# 동북아시아 전통의학 비식물 약재 구성성분 (PubMed 문헌 조사)

한국한의학연구원
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## Chemical constituents of non-botanical medicinal materials in Northeast Asian traditional medicine: A PubMed literature survey

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# 목 차

# 1. 소개

TCM(traditional Chinese medicine)을 포함한 동북아시아 전통의학(Northeast Asian traditional medicine)에서는 오래 전부터 질병을 치료하기 위해 자연에서 구할 수 있는 다양한 약재(medicinal material)들을 사용해 왔다. 대부분 이러한 약재들은 식물의 꽃, 잎, 가지, 뿌리 등을 이용하는 식물 약재(botanical drugs 또는 herbal drugs)들이지만 동물, 조개, 광물 등과 같은 비식물 약재(non-botanical drugs)들도 사용해 왔다. 현대 의학에서는 전통 문헌에서 언급된 이러한 약재들이 실제 유의미한 효능을 보이는지에 대한 evidence 를 과학 기술을 이용해서 밝히는 연구들이 많이 수행되고 있다. 또한, 이와 같은 약재 효능의 evidence 에 대한 연구들이 많이 축적됨에 따라, 최근에는 약재의 phytochemistry 나 pharmacology 에 대한 systematic review 가 증가하고 있으나, 이러한 연구들은 주로 식물 약재들만 다루고 있으며, 상대적으로 비식물 약재들에 대한 연구는 거의 없다.

최근, 다양한 전통의학 약재들의 구성 성분(chemical constituents)들을 체계적으로 집대성한 데이터베이스들이 구축되고 있다. TCM 에서는 최근 Traditional Chinese Medicine Systems Pharmacology (TCMSP) [1], Traditional Chinese Medicine Integrated Database (TCMID) [2], TCM@Taiwan [3]과 같은 데이터베이스가 구축되었는데, 이러한 데이터베이스들에서는 약재와 구성성분뿐만 아니라 이와 연관된 처방, 타겟, 약물, 질병들에 대한 정보들을 같이 제공하고 있다. TCM 데이터베이스 이외에도 전 세계 전통의학 분야에는 많은 데이터베이스들이 존재한다. ConMedNP [4]는 아프리카에서 자연적으로 자라는 식물들에 대한 데이터베이스이며, NuBBE [5]는 브라질의 약용 식물에 대한 정보를 제공한다. 또한, NPACT [6]는 항암에 대한 천연물 데이터베이스이며, BioPhytMol [7]은 항마이코박테리아에 대한 천연물 데이터베이스이다. 이러한 데이터베이스들은 대부분 식물 약재에 대한 구성성분 정보들을 제공하는데, TCMID 와 TCM@Taiwan 은 비식물성 약재에 대해서도 일부 정보들을 제공하고 있다. 하지만, 두 데이터베이스 모두 기존에 출판된 서적에서 정보를 가져왔기 때문에 최신의 연구 결과는 제공하지 못하고 있다.

따라서 이러한 문제를 해결하기 위해서, 한국, 중국, 일본을 포함한 동북아시아 전통의학에서 이용되는 비식물 약재의 구성성분 정보를 PubMed 에서 추출하였다. 그리고 이 정보를 TM-MC [8] 데이터베이스에 추가해서 온라인에서 쉽게 검색할 수 있도록 하였다. <http://informatics.kiom.re.kr/compound>. 본

도서에서는 TM-MC 에 추가된 비식물 약재의 구성성분 정보를 체계적으로 기술한 것으로, 세부적인 정보 추출 방법과 이슈 사항들을 포함해서 약재별로 구성성분을 분류해서 정리하였다. 또한 부록 1 에서는 약재의 구성성분 리스트를 표로 정리하였고, 부록 2 에서는 본 서적에서 사용된 약어 리스트를 기술하였다. 또한 그림을 제외한 본문의 내용은 영어로 번역해서 부록 3 에 수록하였다.

# 2. 정보 추출 방법

약재의 구성성분에 대한 정보는 PubMed 논문에서 추출하였다. PubMed 논문은 Entrez programming utilities (http://www.ncbi.nlm.nih.gov/books/NBK25500)를 이용해서 28 백만번 까지의 PMID(PubMed identifier)를 가지는 논문들을 XML 파일로 다운로드 하였으며, XML 파일에서 제목과 초록을 추출하였다. 약재를 포함하는 논문을 검색하기 위해서 한국, 중국, 일본의 약전에 수재된 약재들 중에서 비식물 약재들의 라틴명(Latin names), 영문명(English names), 학명(scientific names)을 검색어로 이용하였다. 특히, 약재 이름에서 명사의 affix 에 상관 없이 그리고 단어의 순서에 상관 없이 약재를 검색하기 위해서 본 도서에서는 Apache Lucene [9] 을 이용해 논문을 색인하였으며, 이 색인을 가지고 위 약재명들을 검색하였다. 이렇게 해서 232,692 개의 논문이 검색되었으며, 이 논문들 중에서 약재의 성분을 분석한 크로마토그래피 논문들을 필터링하기 위해서 “chromatograph”, “CCC”, “CEC”, “CMC”, “FPLC”, “GC/MS”, “GC-MS”, “GLC”, “GPC”, “HPLC”, “IMAC”, “LC/MS”, “LC-MS”, “MEEKC”, “MEKC”, “NPLC”, “PGC”, “RPC”, “RPLC”, “RSLC”, “SEC”, “SFC”, “SMBC”, “TLC”, “TMBC”, “UFLC”, “UPLC” 의 키워드가 포함된 논문들만 필터링해서 총 11,640 개의 논문을 얻었다. 마지막으로 이렇게 검색 및 필터링된 논문들은 저자들이 직접 읽고 검토해서 비식물 약재의 구성성분을 추출하였다.

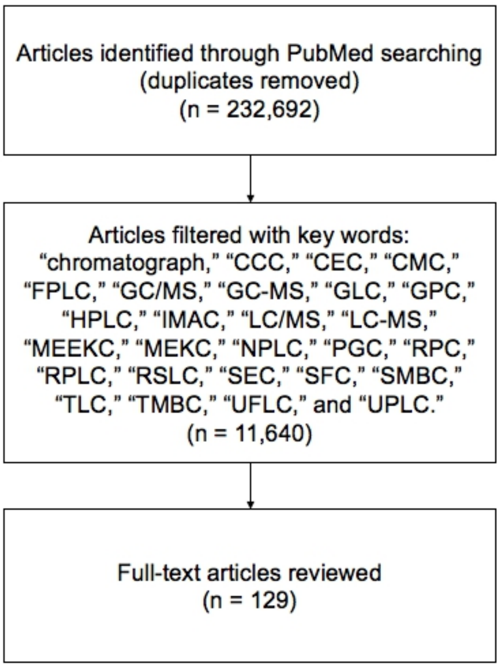



Figure 1. Flow diagram used to construct the information on the chemical constituents of non-botanical medicinal materials.

# 3. 약재의 구성성분

PubMed 에는 총 129 개의 논문들에서 36 개의 비식물 약재들에 대해 432 개의 구성성분 정보가 존재하였다. Table 1 에서 보이는 것과 같이 구성성분의 개수가 가장 많은 약재는 섬수(蟾酥), 봉교(蜂胶), 봉밀(蜂蜜)인 것으로 조사되었다. 또한 Table 2 에서 보이는 것과 같이 중복된 성분을 제거하고 성분의 클래스로 분류했을 때, 가장 많은 화합물을 포함하는 클래스는 steroid, flavonoid, peptide 인 것으로 조사되었다.

Table 1. Number of compounds in each non-botanical medicinal material.

| 한글(한자) | Latin name (Common name) | 개수 |
|---|---|---|
| 섬수(蟾酥) | Bufonis Venenum (Toad venom) | 106 |
| 봉교(蜂胶 | Propolis | 64 |
| 봉밀(蜂蜜) | Mel (Honey) | 37 |
| 해삼(海蔘) | Stichopus (Sea cucumber) | 40 |
| 우황(牛黃) | Bovis Calculus (Cow bezoar or natural Calculus Bovis) | 17 |
| 인공우황(人工牛黄 | Bovis Calculus Artifactus (artificial Calculus Bovis) | 22 |
| 체외배육우황(体外培育牛黄 | Bovis Calculus Sativus | 10 |
| 우담(牛膽) | Bovis Fel (Cattle bile) | 15 |
| 웅담(熊膽) | Ursi Fel (Bear bile) | 16 |
| 저담(猪膽) | Suis Fel (Pig bile) | 16 |
| 사담(蛇膽) | Serpentis Fel (Serpent bile) | 5 |
| 담남성(膽南星) | Arisaema cum Bile | 8 |
| 사향(麝香) | Moschus (Musk) | 35 |
| 녹용(鹿茸) | Cervi Cornu Pantotrichum (Deer antler) | 23 |
| 수우각(水牛角) | Bubali Cornu (Water buffalo horn) | 3 |
| 수질(水蛭) | Hirudo (Leech) | 25 |
| 영와(鈴蛙) | Bombina (Oriental fire-bellied toad) | 2 |
| 오공(蜈蚣) | Scolopendra (Centipede) | 6 |
| 자충(䗪蟲) | Eupolyphaga (Steleophaga or Cockroach) | 1 |
| 맹충(虻蟲) | Tabanus | 6 |
| 반묘(斑猫) | Mylabris | 1 |
| 전갈(全蝎) | Scorpio (Scorpion) | 34 |
| 제조(蠐螬 | Holotrichia (Chafer) | 4 |
| 지룡(地龍) | Pheretima (Earthworm) | 6 |

| | | |
|---|---|---|
| 합마유(哈蟆油) | Ranae Oviductus | 3 |
| 해룡(海龍) | Syngnathus (Pipefish) | 2 |
| 해마(海馬) | Hippocampus (Sea horse) | 5 |
| 백강잠(白殭蠶) | Bombyx Batryticatus | 7 |
| 잠사(蠶沙) | Bombycis Faeces | 21 |
| 노봉방(露蜂房) | Vespae Nidus | 8 |
| 상표초(桑螵蛸) | Mantidis Oötheca (Mantis egg case) | 3 |
| 석결명(石決明) | Haliotidis Concha | 3 |
| 와릉자(瓦楞子) | Arcae Concha | 2 |
| 진주모(珍珠母) | Margaritifera Concha (Mother of pearl or Nacre) | 4 |
| 진주(珍珠) | Margarita (Pearl) | 4 |
| 용골(龍骨) | Fossilia Ossis Mastodi (Longgu) | 18 |

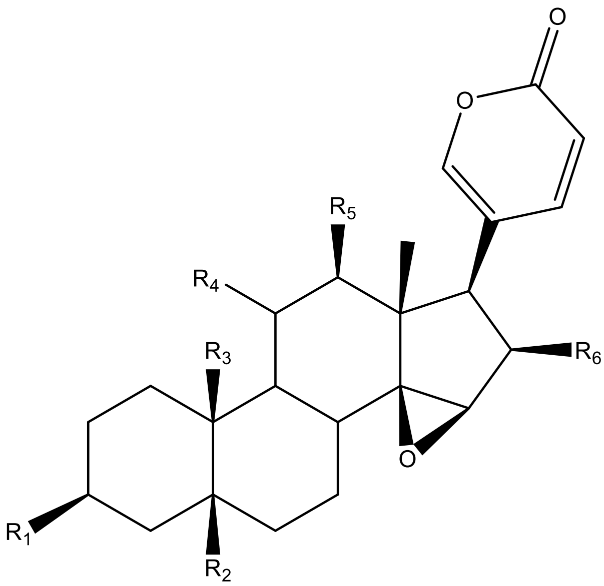
Table 2. Classes of compounds and the number of compounds in each class. The class of “Others” contains compounds for which the number of compounds belonging to a class is one.

| 클래스 | 개수 |
|---|---|
| Steroid | 154 |
| Flavonoid | 37 |
| Peptide | 33 |
| Terpenoid | 31 |
| Protein | 30 |
| Phenolic | 24 |
| Amino acid | 21 |
| Inorganic element | 18 |
| Ester | 13 |
| Nucleoside | 11 |
| Alkaloid | 9 |
| Fatty acid | 8 |
| Glycoprotein | 7 |
| Diarylheptanoid | 6 |
| Lipid | 6 |
| Nucleobase | 6 |
| Alcohol | 3 |
| Aldehyde | 3 |
| Alkane | 3 |
| Saccharide | 3 |
| Ketone | 2 |
| Others | 4 |

각각의 약재의 구성성분 정보는 각 섹션에서 상세히 기술하였다. 하나의 섹션에서 하나의 약재를 기술하고자 하였으나, 동물의 담즙에 대한 약재들의 경우 약재들의 구성성분들이 유사하여 하나의 섹션에 포함하였으며, Margaritifera Concha 와 Margarita 는 하나의 생물종일뿐만 아니라 추출된 성분도 동일하여 하나의 섹션에 포함하였다. 각 약재의 이름은 한글, 한자, 중국약전에 나오는 라틴명을 같이 기술하였으며, 영문명이 있는 경우 영문명도 언급하였고, 각 섹션안에서 한국, 중국, 일본 약전에 나오는 학명들과 과명(Family name)도 기술하였다.

### 3.1. 섬수(蟾酥), Bufonis Venenum

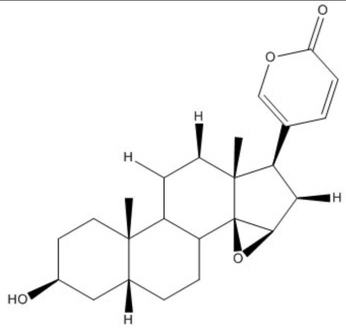
섬수(蟾酥, Bufonis Venenum, Toad Venom)는 Bufonidae 과에 속하는 두꺼비(*Bufo bufo gargarizans* Cantor, *Bufo melanostictus* Schneider)의 auricular gland 에서 분비된 흰색의 분비물을 건조한 것이다. 섬수의 주요 성분은 C-17 위치에 α-2-pyrone ring 을 가지는 C-24 steroid 의 한 종류인 bufadienolide 이며, bufadienolide 는 크게 14,15-epoxy group 과 14-hydroxy group 으로 나뉘어 진다. 그 동안 많은 연구들에서 서로 다른 방법을 이용해서 bufadienolide 들을 추출했는데 [10-17], 섬수에서 bufadienolide 의 함유량은 연구들마다 매우 차이가 많이 났다. 특히, **(1)** resibufogenin, **(13)** cinobufagin, **(45)** bufalin, **(59)** bufotalin 의 성분들은 전체 bufadienolide 의 80% 이상을 차지한다고 알려져 있다 [10].



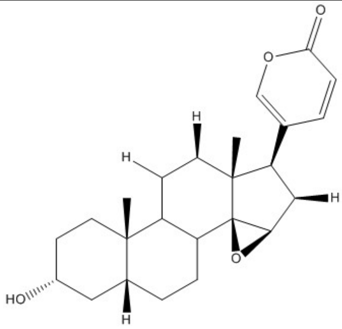

| No | Compound | $R_1$ | $R_2$ | $R_3$ | $R_4$ | $R_5$ | $R_6$ | PubChem | Ref. |
|---|---|---|---|---|---|---|---|---|---|
| **(1)** | resibufogenin (bufogenin) | OH | H | $CH_3$ | H | H | H | 6917974 | [10-19] |
| **(2)** | 3-epi-resibufogenin | α-OH | H | $CH_3$ | H | H | H | | [19] |
| **(3)** | resibufagin | OH | H | CHO | H | H | H | 12314890 | [11-13, 18, 19] |
| **(4)** | desacetylcinobufagin | OH | H | $CH_3$ | H | H | OH | 19937 | [11-14, 18, 19] |
| **(5)** | marinobufagin | OH | OH | $CH_3$ | H | H | H | 10104 | [10-13, 18] |
| **(6)** | bufotalinin | OH | OH | CHO | H | H | H | 11225 | [11, 15, 18] |
| **(7)** | desacetylcinobufotalin (de-O-acetylcinobufotalin) | OH | OH | $CH_3$ | H | H | OH | 15513544 | [11, 13, 14, 18] |
| **(8)** | 11-hydroxyresibufogenin | OH | H | $CH_3$ | OH | H | H | | [12] |
| **(9)** | 12β-hydroxyresibufogenin | OH | H | $CH_3$ | H | OH | H | | [11, 18] |
| **(10)** | 19-oxo-desacetylcinobufagin | OH | H | CHO | H | H | OH | 11144140 | [11] |
| **(11)** | 22,23-epoxyresibufogenin* | OH | H | $CH_3$ | H | H | H | | [12] |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **(12)** | resibufaginol | OH | H | $CH_2OH$ | H | H | H | | [13] |
| **(13)** | cinobufagin | OH | H | $CH_3$ | H | H | OAc | 11969542 | [10-19] |
| **(14)** | cinobufaginol | OH | H | $CH_2OH$ | H | H | OAc | 12303266 | [11, 18] |
| **(15)** | cinobufotalin | OH | OH | $CH_3$ | H | H | OAc | 92043080 | [10, 11, 13-16, 18, 19] |
| **(16)** | 22,23-epoxycinobufotalin* | OH | OH | $CH_3$ | H | H | OAc | | [12] |
| **(17)** | 3-oxo-cinobufagin | =O | H | CHO | H | H | OAc | | [19] |
| **(18)** | 3-oxo-cinobufotalin | =O | OH | $CH_3$ | H | H | OAc | 102253150 | [15] |
| **(19)** | 12β-hydroxycinobufagin | OH | H | $CH_3$ | H | OH | OAc | | [10, 11, 19] |
| **(20)** | 5,12β-dihydroxycinobufagin | OH | OH | $CH_3$ | H | OH | OAc | | [10] |
| **(21)** | 19-oxo-cinobufagin | OH | H | CHO | H | H | OAc | 102093791 | [10, 11, 13, 15, 19] |
| **(22)** | 19-oxo-cinobufotalin | OH | OH | CHO | H | H | OAc | 102093790 | [10-13, 18] |
| **(23)** | resibufogenin-3-O-succinate-arginine | $OCO(CH_2)_2COOArg$ | H | $CH_3$ | H | H | H | | [10, 11] |
| **(24)** | resibufaginol-3-O-succinate-arginine | $OCO(CH_2)_2COOArg$ | H | $CH_2OH$ | H | H | H | | [19] |
| **(25)** | cinobufagin-3-O-succinate-arginine | $OCO(CH_2)_2COOArg$ | H | $CH_3$ | H | H | OAc | | [10, 11, 19] |
| **(26)** | cinobufaginol-3-O-succinate-arginine | $OCO(CH_2)_2COOArg$ | H | $CH_2OH$ | H | H | OAc | | [11] |
| **(27)** | resibufogenin-3-O-glutarate-arginine | $OCO(CH_2)_3COOArg$ | H | $CH_3$ | H | H | H | | [19] |
| **(28)** | cinobufagin-3-O-glutarate-arginine | $OCO(CH_2)_3COOArg$ | H | $CH_3$ | H | H | OAc | | [10] |
| **(29)** | marinobufotoxin (marinobufagin 3-suberoylarginine ester) | $OCO(CH_2)_4COOArg$ | OH | $CH_3$ | H | H | H | 101996079 | [10] |
| **(30)** | cinobufagin-3-O-adipate-arginine | $OCO(CH_2)_4COOArg$ | H | $CH_3$ | H | H | OAc | | [10, 11, 19] |
| **(31)** | 19-oxo-cinobufotalin-3-O-adipate-arginine | $OCO(CH_2)_4COOArg$ | OH | CHO | H | H | OAc | | [10] |
| **(32)** | resibufogenin-3-O-pimelate-arginine | $OCO(CH_2)_5COOArg$ | H | $CH_3$ | H | H | H | | [10, 11] |
| **(33)** | cinobufagin-3-O-pimelate-arginine | $OCO(CH_2)_5COOArg$ | H | $CH_3$ | H | H | OAc | | [10, 19] |
| **(34)** | cinobufaginol-3-O-pimelate-arginine | $OCO(CH_2)_5COOArg$ | H | $CH_2OH$ | H | H | OAc | | [19] |
| **(35)** | cinobufotalitoxin | $OCO(CH_2)_5COOArg$ | OH | $CH_3$ | H | H | OAc | | [10] |
| **(36)** | resibufogenin-3-O-suberate | $OCO(CH_2)_6COOH$ | H | $CH_3$ | H | H | H | | [13] |
| **(37)** | cinobufagin-3-O-suberate | $OCO(CH_2)_6COOH$ | H | $CH_3$ | H | H | OAc | | [13] |
| **(38)** | resibufotoxin (resibufogenin-3-O-suberate-arginine) | $OCO(CH_2)_6COOArg$ | H | $CH_3$ | H | H | H | 101307888 | [10, 19] |
| **(39)** | cinobufotoxin (cinobufagin-3-O-suberate-arginine) | $OCO(CH_2)_6COOArg$ | H | $CH_3$ | H | H | OAc | 102003563 | [10, 11] |
| **(40)** | cinobufaginol-3-O-suberate-arginine | $OCO(CH_2)_6COOArg$ | H | $CH_2OH$ | H | H | OAc | | [19] |
| **(41)** | 19-oxo-cinobufotalin-3-O-suberate-arginine | $OCO(CH_2)_6COOArg$ | OH | CHO | H | H | OAc | | [19] |
| **(42)** | 19-oxo-cinobufotalin-3-O-suberate-methylhistidine | $OCO(CH_2)_6COOMethylHis$ | OH | CHO | H | H | OAc | | [10] |
| **(43)** | cinobufagin-3-O-nonanedioic-arginine | $OCO(CH_2)_7COOArg$ | H | $CH_3$ | H | H | OAc | | [10] |
| **(44)** | bufotalinin-3-O-sebacate-arginine | $OCO(CH_2)_8COOArg$ | OH | CHO | H | H | H | | [12] |

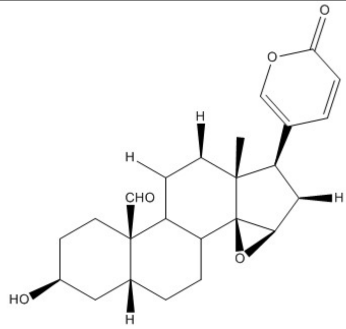
Figure 2. Chemical structures of 14,15-epoxy bufadienolides identified in Bufonis Venenum. * 22,23-epoxy exists.



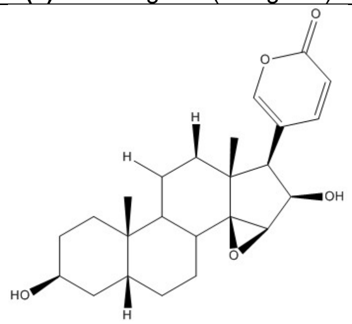

**(1)** resibufogenin (bufogenin)



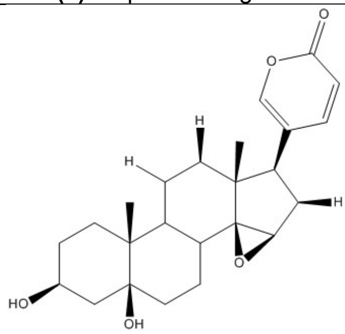

**(2)** 3-epi-resibufogenin



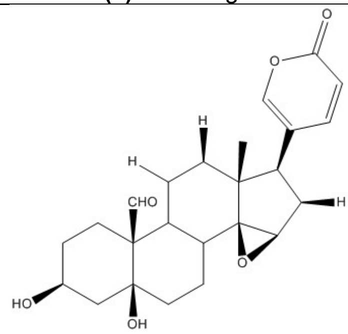

**(3)** resibufagin



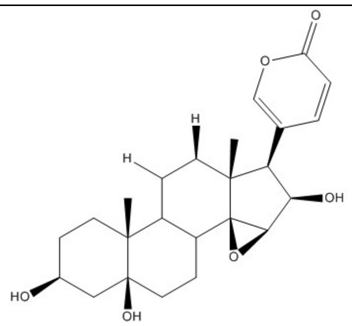

**(4)** desacetylcinobufagin



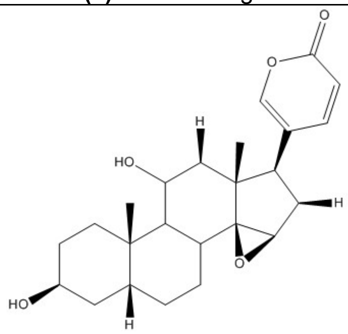

**(5)** marinobufagin



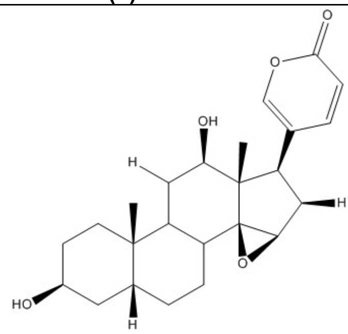

**(6)** bufotalinin



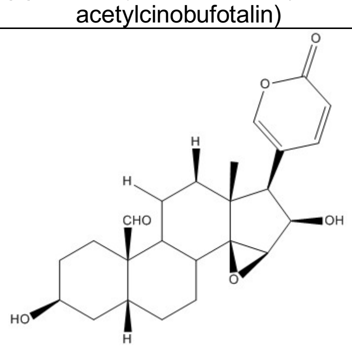

**(7)** desacetylcinobufotalin (de-O-acetylcinobufotalin)



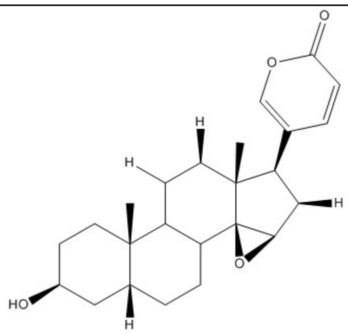

**(8)** 11-hydroxyresibufogenin



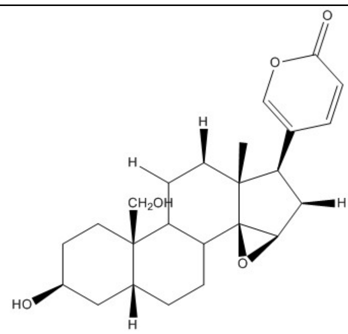

**(9)** 12β-hydroxyresibufogenin



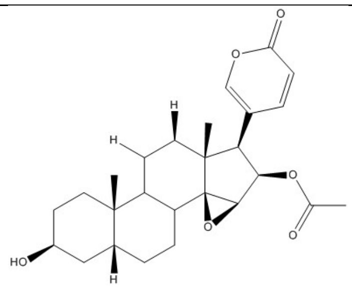

**(10)** 19-oxo-desacetylcinobufagin



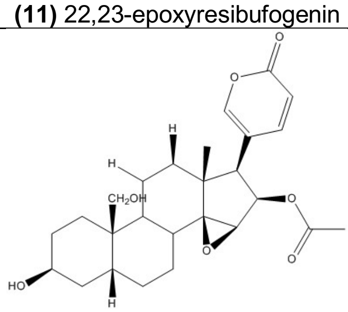

**(11)** 22,23-epoxyresibufogenin



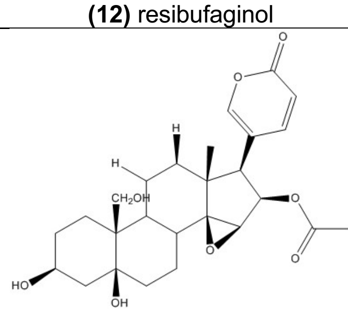

**(12)** resibufaginol



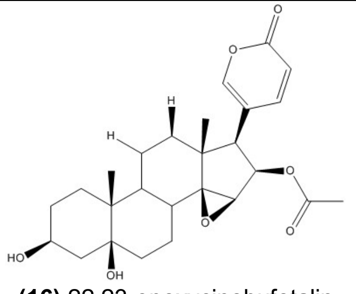

**(13)** cinobufagin



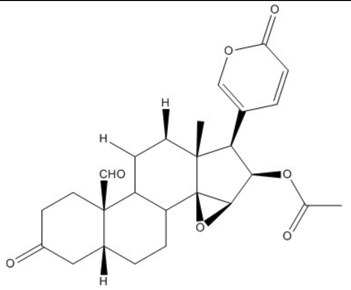

**(14)** cinobufaginol



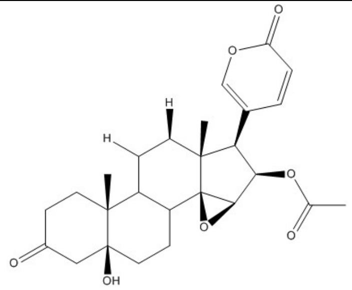

**(15)** cinobufotalin



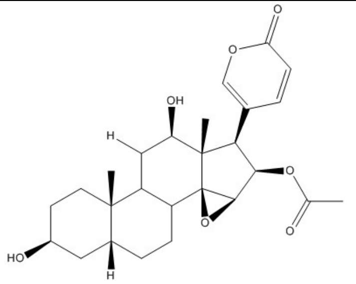
**(16)** 22,23-epoxycinobufotalin



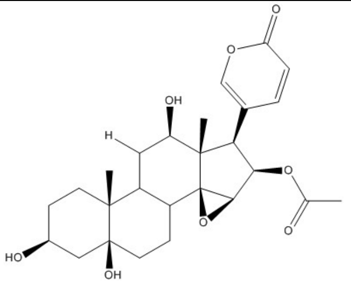
**(17)** 3-oxo-cinobufagin



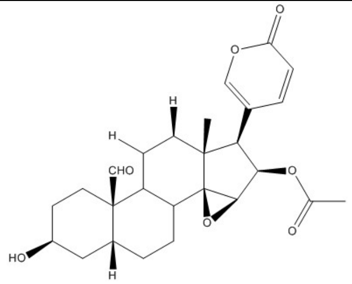
**(18)** 3-oxo-cinobufotalin



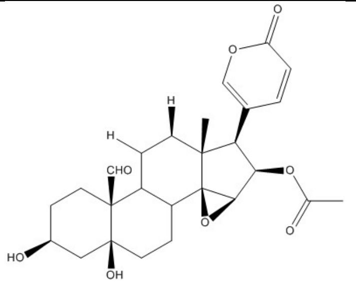
**(19)** 12β-hydroxycinobufagin



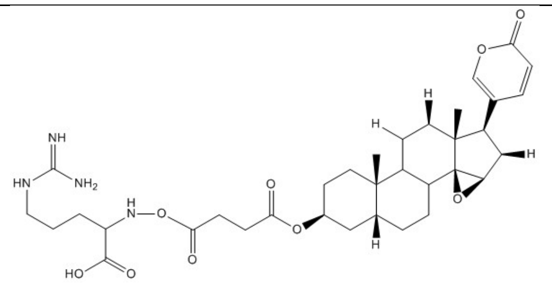
**(20)** 5,12β-dihydroxycinobufagin



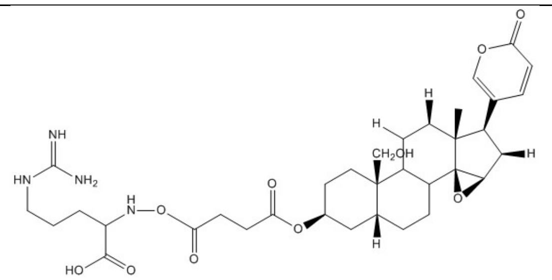
**(21)** 19-oxo-cinobufagin



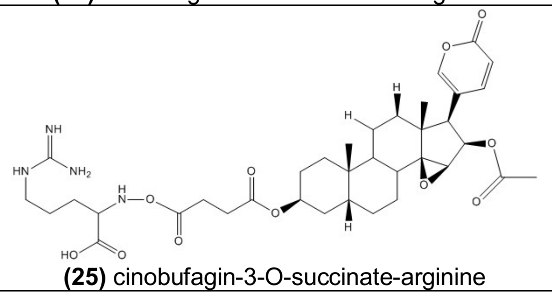
**(22)** 19-oxo-cinobufotalin



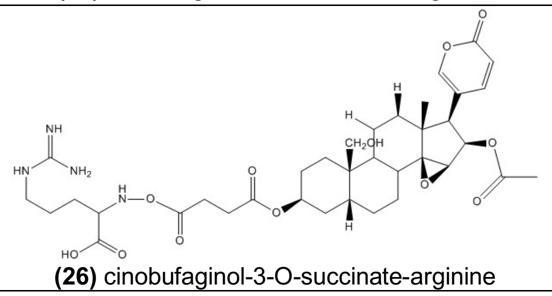
**(23)** resibufogenin-3-O-succinate-arginine



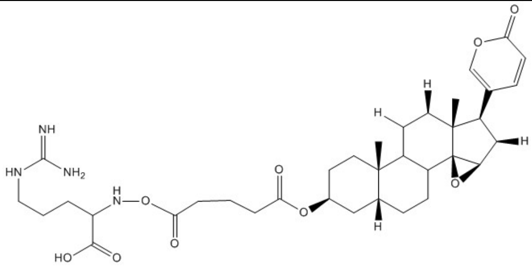
**(24)** resibufaginol-3-O-succinate-arginine



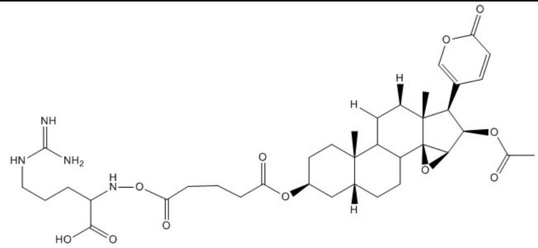
**(25)** cinobufagin-3-O-succinate-arginine



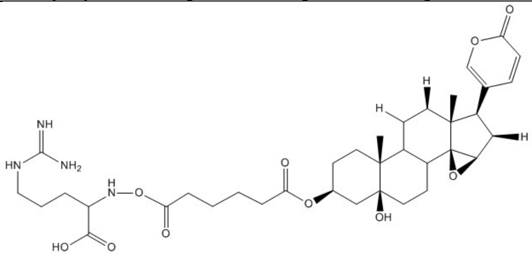
**(26)** cinobufaginol-3-O-succinate-arginine



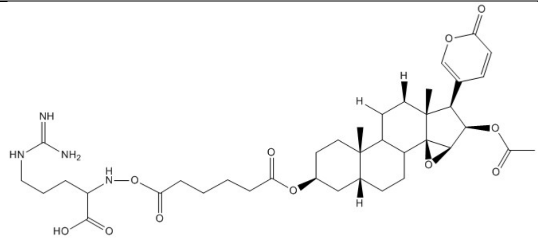
**(27)** resibufogenin-3-O-glutarate-arginine



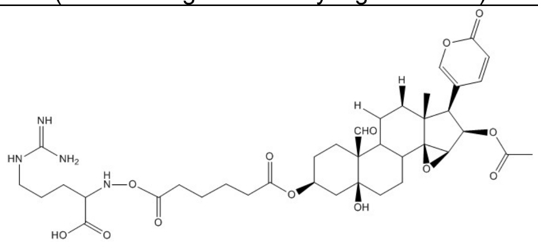
**(28)** cinobufagin-3-O-glutarate-arginine



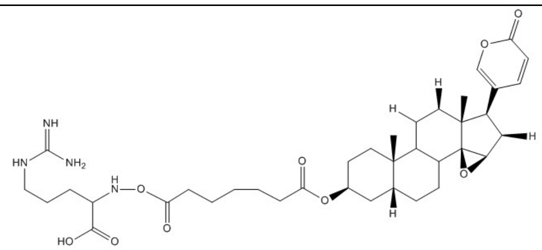
**(29)** marinobufotoxin
(marinobufagin 3-suberoylarginine ester)



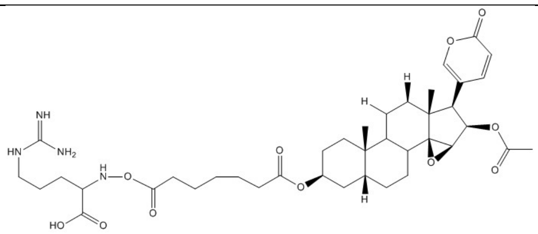
**(30)** cinobufagin-3-O-adipate-arginine



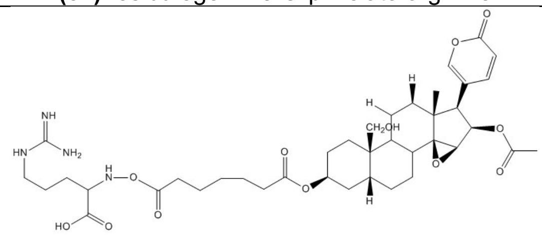
**(31)** 19-oxo-cinobufotalin-3-O-adipate-arginine



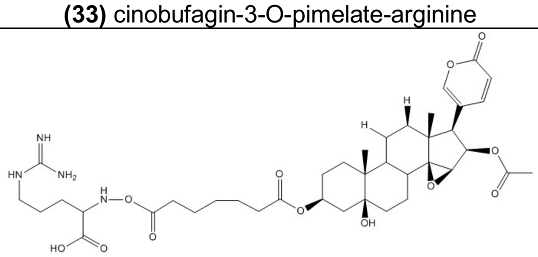
**(32)** resibufogenin-3-O-pimelate-arginine



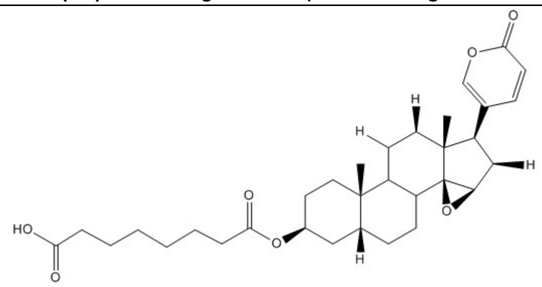
**(33)** cinobufagin-3-O-pimelate-arginine



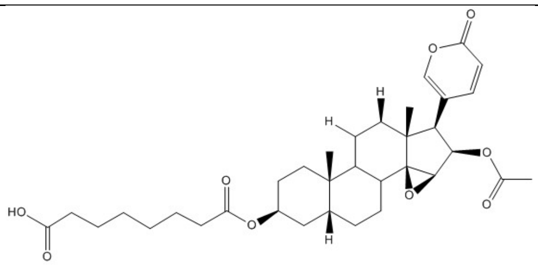
**(34)** cinobufaginol-3-O-pimelate-arginine



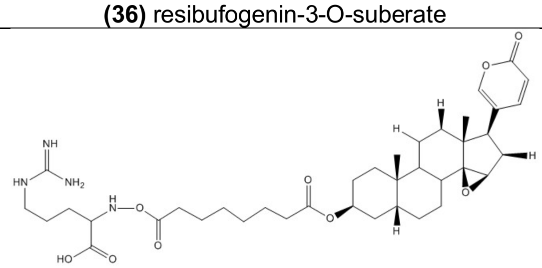
**(35)** cinobufotalitoxin



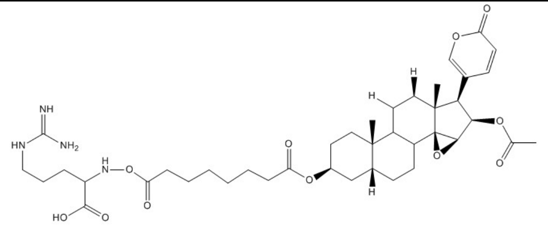
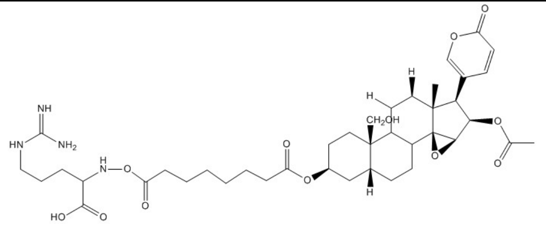
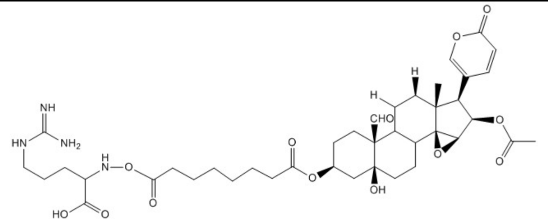
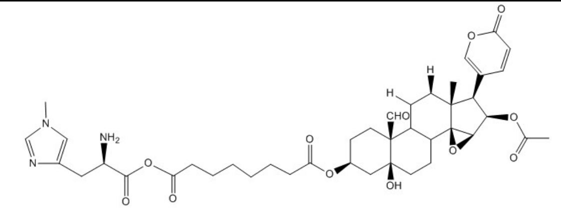
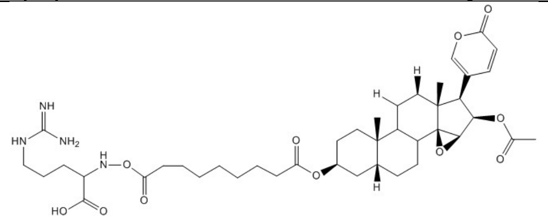
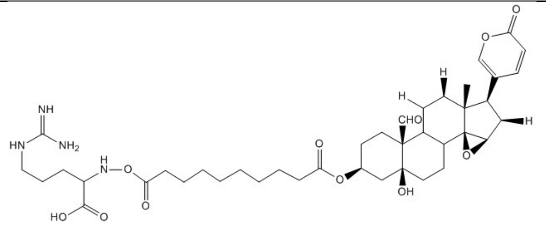
**(36)** resibufogenin-3-O-suberate

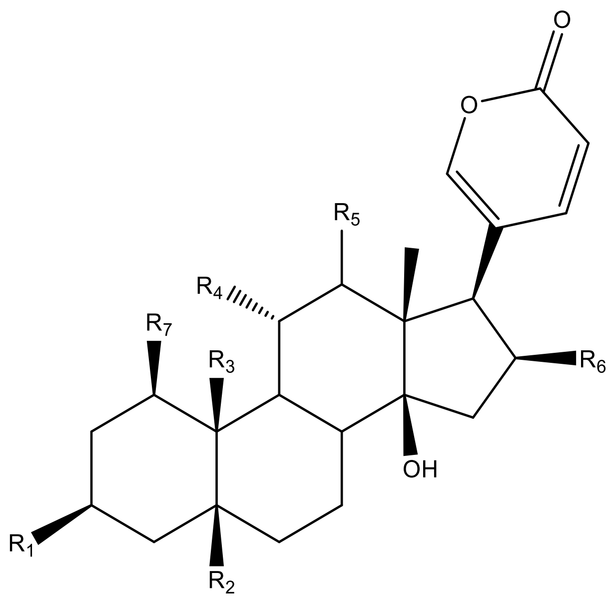


**(37)** cinobufagin-3-O-suberate



**(38)** resibufotoxin (resibufogenin-3-O-suberate-arginine)

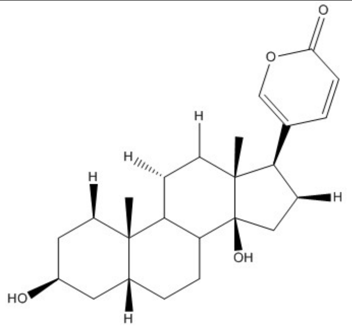
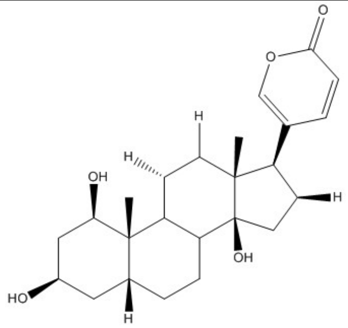
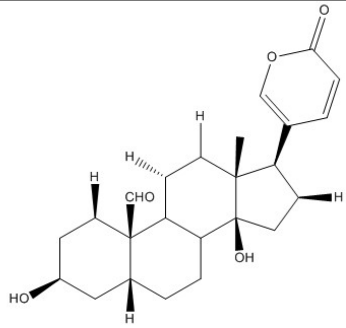
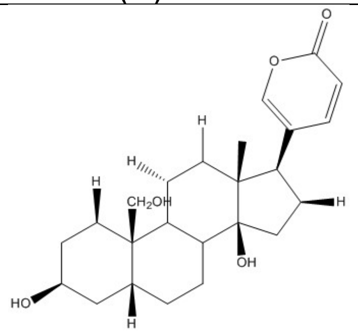
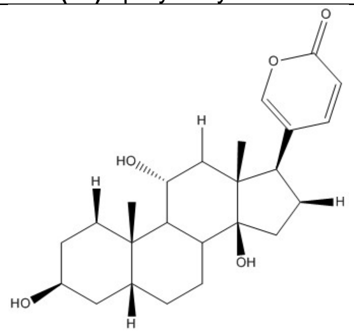
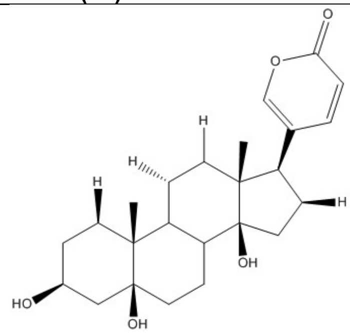
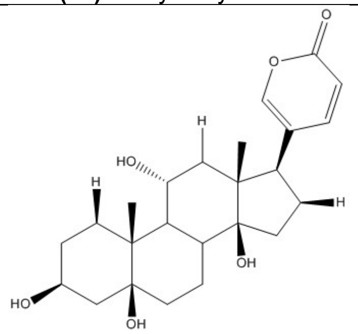
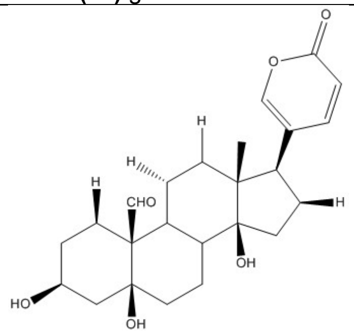
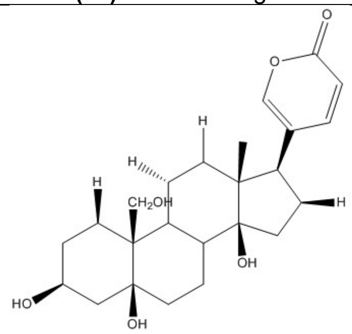
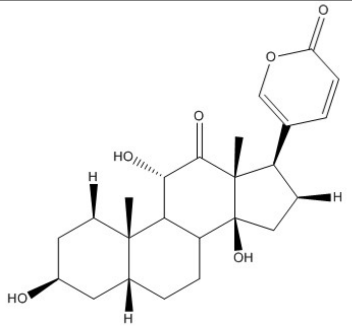
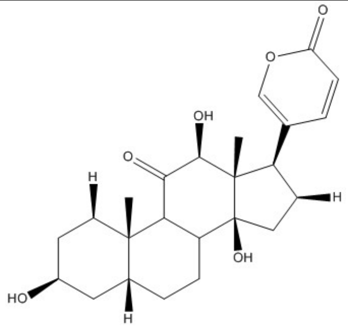
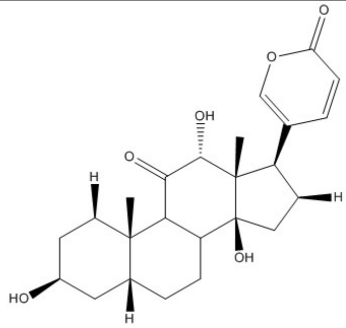
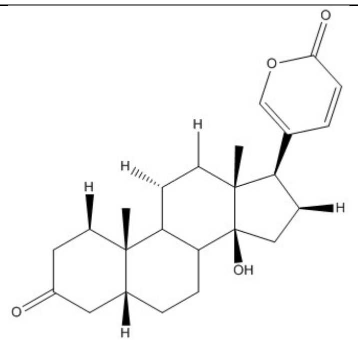
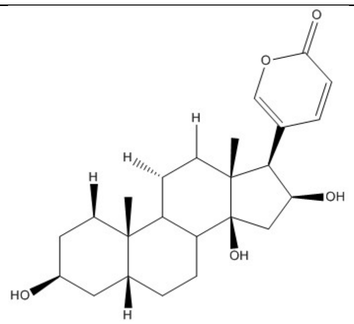
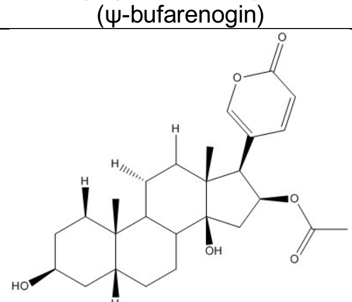
| | |
|---|---|
| <br>**(39)** cinobufotoxin (cinobufagin-3-O-suberate-arginine) | <br>**(40)** cinobufaginol-3-O-suberate-arginine |
| <br>**(41)** 19-oxo-cinobufotalin-3-O-suberate-arginine | <br>**(42)** 19-oxo-cinobufotalin-3-O-suberate-methylhistidine |
| <br>**(43)** cinobufagin-3-O-nonanedioic-arginine | <br>**(44)** bufotalinin-3-O-sebacate-arginine |

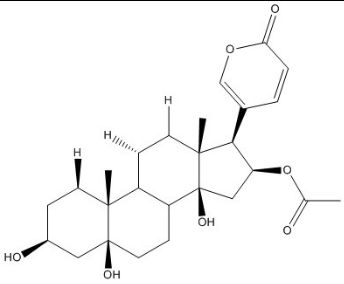



| No | Compound | $R_1$ | $R_2$ | $R_3$ | $R_4$ | $R_5$ | $R_6$ | $R_7$ | PubChem | Ref. |
|---|---|---|---|---|---|---|---|---|---|---|
| **(45)** | bufalin | OH | H | $CH_3$ | H | H | H | H | 34174823 | [10-19] |
| **(46)** | 1β-hydroxybufalin | OH | H | $CH_3$ | H | H | H | OH | | [11] |
| **(47)** | 19-oxo-bufalin | OH | H | CHO | H | H | H | H | 10883889 | [11, 13, 18] |
| **(48)** | 19-hydroxybufalin | OH | H | $CH_2OH$ | H | H | H | H | 101375811 | [11-13] |
| **(49)** | gamabufotalin | OH | H | $CH_3$ | OH | H | H | H | 259803 | [10-15, 17-19] |
| **(50)** | telocinobufagin | OH | OH | $CH_3$ | H | H | H | H | 259991 | [10-15, 18] |
| **(51)** | 11α-hydroxytelocinobufagin | OH | OH | $CH_3$ | OH | H | H | H | | [10] |
| **(52)** | hellebrigenin | OH | OH | CHO | H | H | H | H | 259577 | [11, 13] |
| **(53)** | hellebrigenol (19-hydroxytelocinobufagin) | OH | OH | $CH_2OH$ | H | H | H | H | 10432170 | [13] |
| **(54)** | arenobufagin | OH | H | $CH_3$ | OH | =O | H | H | 12305198 | [10-15, 18] |
| **(55)** | bufarenogin | OH | H | $CH_3$ | =O | β-OH | H | H | 167607 | [10, 13, 18, 19] |
| **(56)** | φ-bufarenogin (ψ-bufarenogin) | OH | H | $CH_3$ | =O | α-OH | H | H | | [12, 13, 15, 18] |
| **(57)** | bufalone | =O | H | $CH_3$ | H | H | H | H | 99606 | [10] |
| **(58)** | desacetylbufotalin | OH | H | $CH_3$ | H | H | OH | H | 12358889 | [11, 13, 14] |
| **(59)** | bufotalin | OH | H | $CH_3$ | H | H | OAc | H | 12302120 | [10-15, 17-19] |
| **(60)** | 5-hydroxybufotalin | OH | OH | $CH_3$ | H | H | OAc | H | | [13] |
| **(61)** | 16-O-acetylarenobufagin | OH | H | $CH_3$ | OH | =O | OAc | H | | [13, 20] |
| **(62)** | 16-acetoxybufarenogin | OH | H | $CH_3$ | =O | β-OH | OAc | H | | [10] |
| **(63)** | gamabufotalin-3-O-sulfate | $OSO_3H$ | H | $CH_3$ | OH | H | H | H | | [10] |
| **(64)** | arenobufagin-3-O-sulfate | $OSO_3H$ | H | $CH_3$ | OH | =O | H | H | | [10] |
| **(65)** | bufotalin-3-O-sulfate | $OSO_3H$ | H | $CH_3$ | H | H | OAc | H | | [10] |
| **(66)** | 19-hydroxybufalin-3-O-sulfate | $OSO_3H$ | H | $CH_2OH$ | H | H | H | H | | [13, 20] |
| **(67)** | telocinobufagin-3-O-sulfate | $OSO_3H$ | OH | $CH_3$ | H | H | H | H | | [13, 20] |

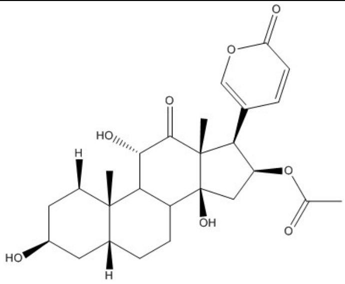
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **(68)** | desacetylbufotalin-3-O-sulfate | $OSO_3H$ | H | $CH_3$ | H | H | OH | H | | [13, 20] |
| **(69)** | hellebrigenin-3-O-sulfate | $OSO_3H$ | OH | CHO | H | H | H | H | | [13, 20] |
| **(70)** | hellebrigenol-3-O-sulfate | $OSO_3H$ | OH | $CH_2OH$ | H | H | H | H | | [13, 20] |
| **(71)** | gamabufotalin-3-oxalate | OCOCOOH | H | $CH_3$ | OH | H | H | H | | [12] |
| **(72)** | bufalin-3-O-suberate | $OCO(CH_2)_6COOH$ | H | $CH_3$ | H | H | H | H | | [13] |
| **(73)** | gamabufotalin-3-O-suberate | $OCO(CH_2)_6COOH$ | H | $CH_3$ | OH | H | H | H | | [10] |
| **(74)** | bufalin-3-O-succinate-arginine | $OCO(CH_2)_2COOArg$ | H | $CH_3$ | H | H | H | H | | [10-12] |
| **(75)** | gamabufotalin-3-O-succinate-arginine | $OCO(CH_2)_2COOArg$ | H | $CH_3$ | OH | H | H | H | | [10] |
| **(76)** | bufalone-3-O-succinate-arginine | $OCO(CH_2)_2COOArg$ | H | $CH_3$ | H | H | H | H | | [10] |
| **(77)** | bufotalin-3-O-succinate-arginine | $OCO(CH_2)_2COOArg$ | H | $CH_3$ | H | H | OAc | H | | [10] |
| **(78)** | bufotalin-3-O-glutarate-arginine | $OCO(CH_2)_3COOArg$ | H | $CH_3$ | H | H | OAc | H | | [12] |
| **(79)** | bufalin-3-O-glutarate-arginine | $OCO(CH_2)_3COOArg$ | H | $CH_3$ | H | H | H | H | | [19] |
| **(80)** | bufalin-3-O-adipate-arginine | $OCO(CH_2)_4COOArg$ | H | $CH_3$ | H | H | H | H | | [10-12] |
| **(81)** | gamabufotalin-3-O-adipate-arginine | $OCO(CH_2)_4COOArg$ | H | $CH_3$ | OH | H | H | H | | [10] |
| **(82)** | gamabufotalin-3-O-pimelate-arginine | $OCO(CH_2)_5COOArg$ | H | $CH_3$ | OH | H | H | H | | [10] |
| **(83)** | bufalin-3-O-pimelate-arginine | $OCO(CH_2)_5COOArg$ | H | $CH_3$ | H | H | H | H | | [19] |
| **(84)** | bufotalin-3-O-pimelate-arginine | $OCO(CH_2)_5COOArg$ | H | $CH_3$ | H | H | OAc | H | | [10] |
| **(85)** | gamabufotalitoxin (gamabufotalin-3-O-suberate-arginine) | $OCO(CH_2)_6COOArg$ | H | $CH_3$ | OH | H | H | H | 86341923 | [10-12, 19] |
| **(86)** | arenobufotoxin | $OCO(CH_2)_6COOArg$ | H | $CH_3$ | OH | =O | H | H | 198386 | [10] |
| **(87)** | bufotalin-3-O-suberate- arginine | $OCO(CH_2)_6COOArg$ | H | $CH_3$ | H | H | OAc | H | | [19] |
| **(88)** | bufotalin-3-O-suberate-histidine | $OCO(CH_2)_6COOHis$ | H | $CH_3$ | H | H | OAc | H | | [10] |
| **(89)** | bufalin-3-O-suberate-methylhistidine | $OCO(CH_2)_6COOMethyl$ His | H | $CH_3$ | H | H | H | H | | [10] |
| **(90)** | bufalitoxin | $OCO(CH_2)_6COOArg$ | H | $CH_3$ | H | H | H | H | 99882 | [10] |
| **(91)** | telocinobufatoxin (telocinobufagin-3-O-suberate-arginine) | $OCO(CH_2)_6COOArg$ | OH | $CH_3$ | H | H | H | H | 156077 | [10-12, 19] |
| **(92)** | hellebritoxin (hellebrigenin-3-O-suberate-arginine) | $OCO(CH_2)_6COOArg$ | OH | CHO | H | H | H | H | | [10, 11, 19] |
| **(93)** | bufotoxin | $OCO(CH_2)_6COOArg$ | H | $CH_3$ | H | H | OAc | H | 20054854 | [10] |
| **(94)** | 3β,14β,19β-trihydroxybufa-20,22-dienolide; 3-O-suberate-L-histidine | $OCO(CH_2)_6COOHis$ | H | $CH_3$ | H | H | H | H | | [10] |
| **(95)** | gamabufotalin-3-O-pelargonate-arginine | $OCO(CH_2)_7COOArg$ | H | $CH_3$ | OH | H | H | H | | [12] |
| **(96)** | bufalin-3-O-sebacate-arginine | $OCO(CH_2)_8COOArg$ | H | $CH_3$ | H | H | H | H | | [12] |

Figure 3. Chemical structures of 14-hydroxy bufadienolides identified in Bufonis Venenum.

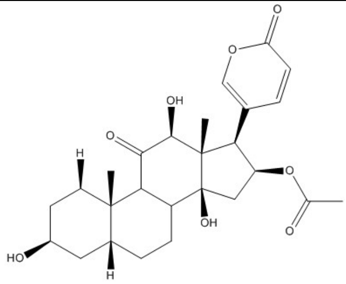
| | | |
|---|---|---|
|  **(45)** bufalin |  **(46)** 1β-hydroxybufalin |  **(47)** 19-oxo-bufalin |
|  **(48)** 19-hydroxybufalin |  **(49)** gamabufotalin |  **(50)** telocinobufagin |
|  **(51)** 11α-hydroxytelocinobufagin |  **(52)** hellebrigenin |  **(53)** hellebrigenol (19-hydroxytelocinobufagin) |
|  **(54)** arenobufagin |  **(55)** bufarenogin |  **(56)** φ-bufarenogin (ψ-bufarenogin) |
|  **(57)** bufalone |  **(58)** desacetylbufotalin |  **(59)** bufotalin |



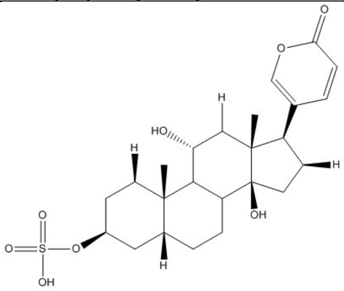
**(60)** 5-hydroxybufotalin



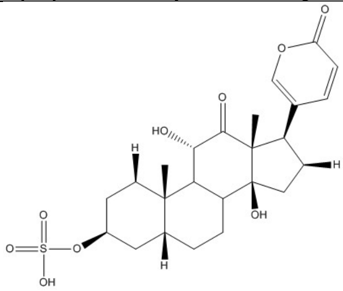
**(61)** 16-O-acetylarenobufagin



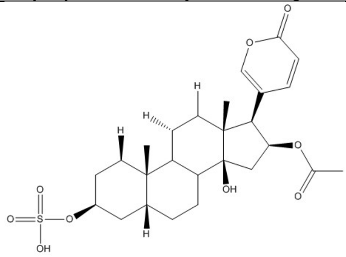
**(62)** 16-acetoxybufarenogin



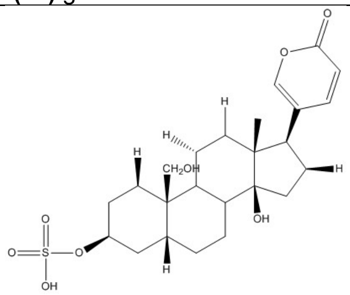
**(63)** gamabufotalin-3-O-sulfate



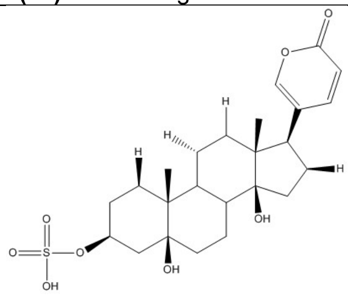
**(64)** arenobufagin-3-O-sulfate



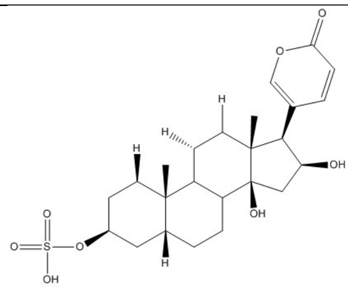
**(65)** bufotalin-3-O-sulfate



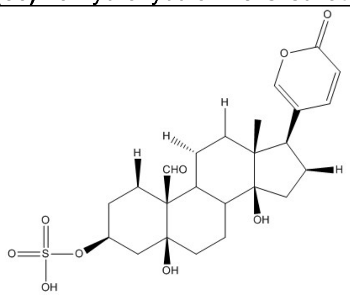
**(66)** 19-hydroxybufalin-3-O-sulfate



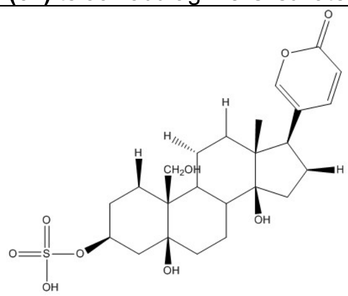
**(67)** telocinobufagin-3-O-sulfate



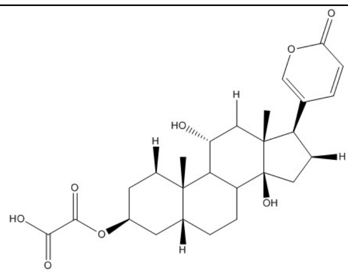
**(68)** desacetylbufotalin-3-O-sulfate



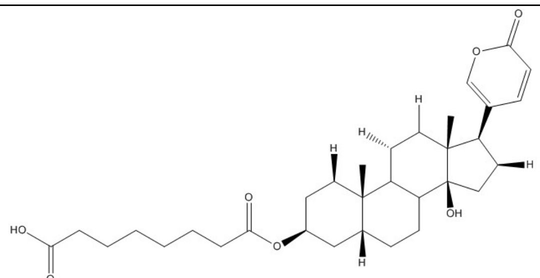
**(69)** hellebrigenin-3-O-sulfate



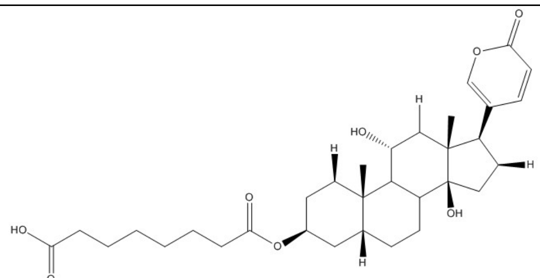
**(70)** hellebrigenol-3-O-sulfate



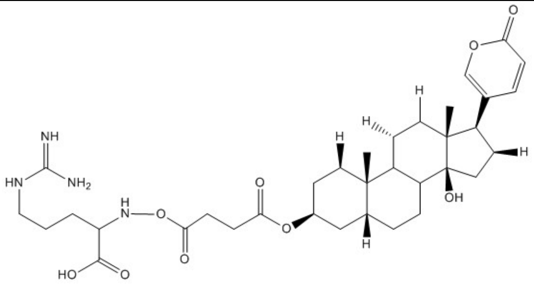
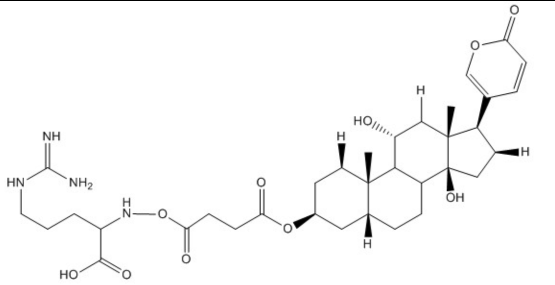
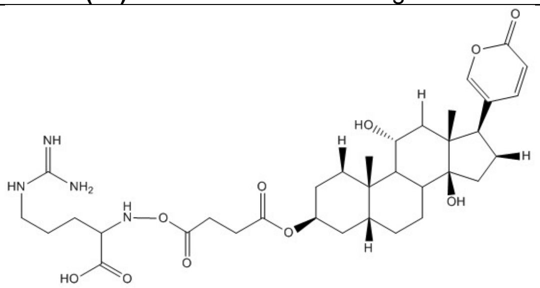
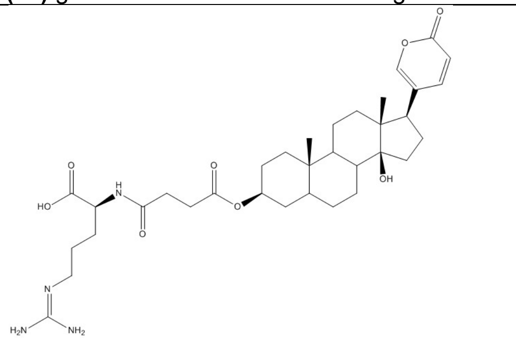
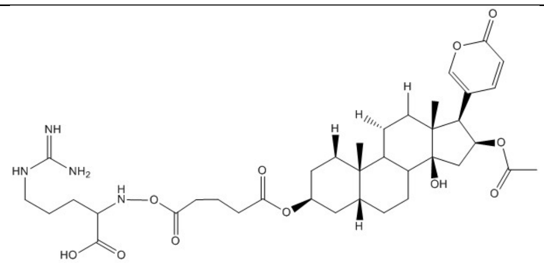
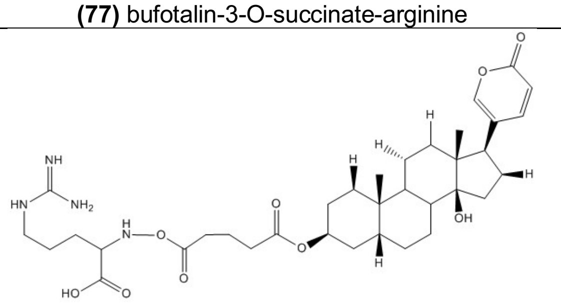
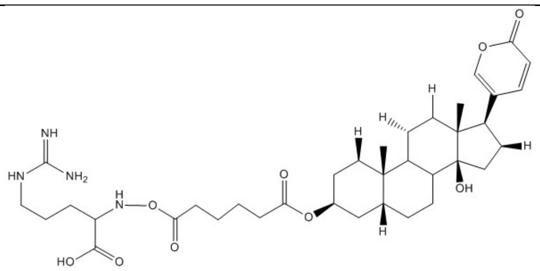
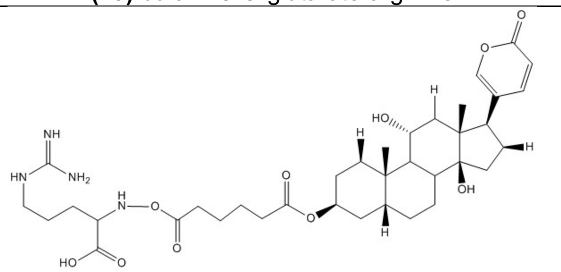
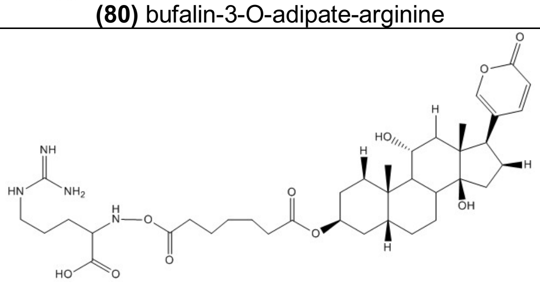
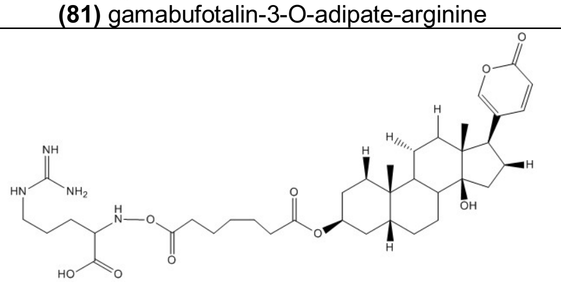
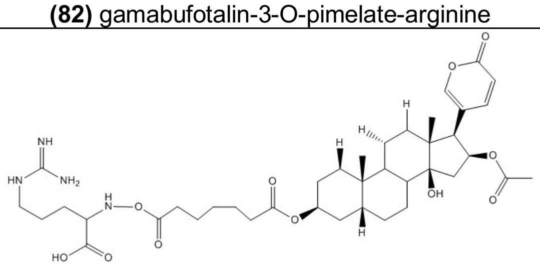
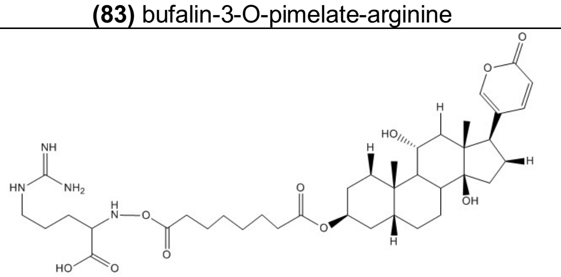
**(71)** gamabufotalin-3-oxalate

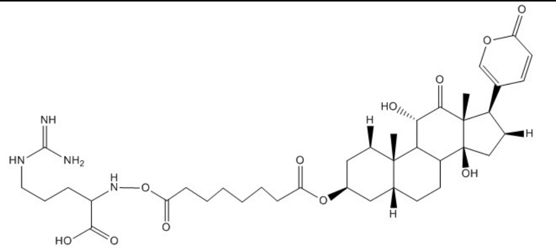


**(72)** bufalin-3-O-suberate

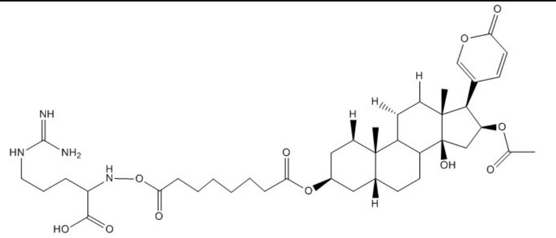


**(73)** gamabufotalin-3-O-suberate

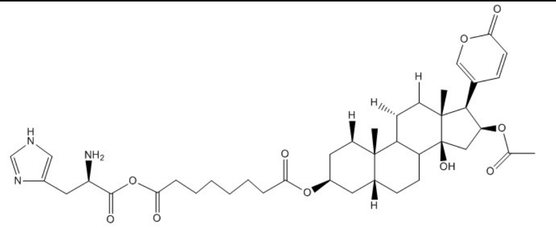
| | |
|---|---|
|  **(74)** bufalin-3-O-succinate-arginine |  **(75)** gamabufotalin-3-O-succinate-arginine |
|  **(76)** bufalone-3-O-succinate-arginine |  **(77)** bufotalin-3-O-succinate-arginine |
|  **(78)** bufotalin-3-O-glutarate-arginine |  **(79)** bufalin-3-O-glutarate-arginine |
|  **(80)** bufalin-3-O-adipate-arginine |  **(81)** gamabufotalin-3-O-adipate-arginine |
|  **(82)** gamabufotalin-3-O-pimelate-arginine |  **(83)** bufalin-3-O-pimelate-arginine |
|  **(84)** bufotalin-3-O-pimelate-arginine |  **(85)** gamabufotalitoxin (gamabufotalin-3-O-suberate-arginine) |



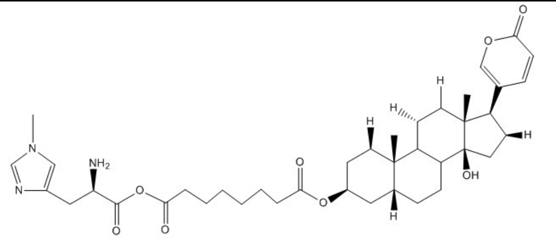
**(86)** arenobufotoxin



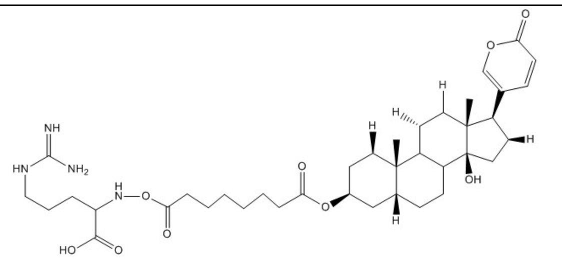
**(87)** bufotalin-3-O-suberate-arginine



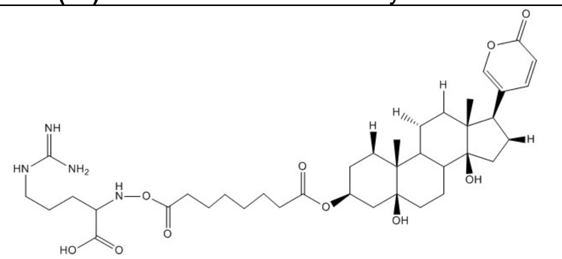
**(88)** bufotalin-3-O-suberate-histidine



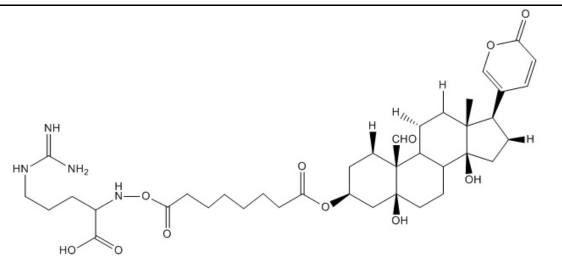
**(89)** bufalin-3-O-suberate-methylhistidine



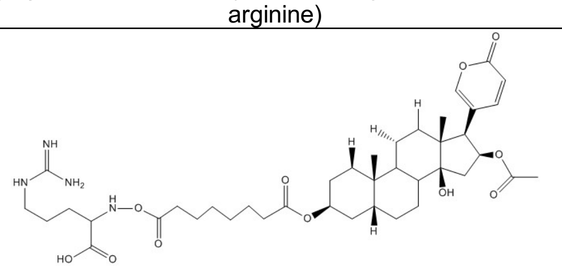
**(90)** bufalitoxin



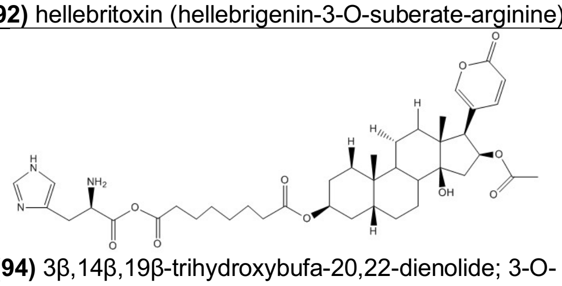
**(91)** telocinobufatoxin (telocinobufagin-3-O-suberate-arginine)



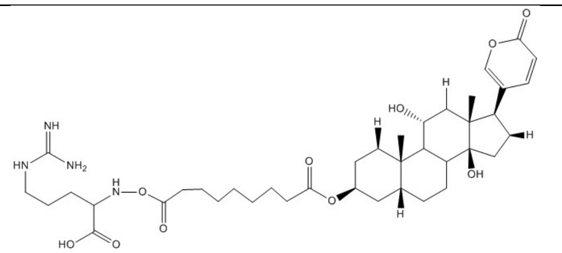
**(92)** hellebritoxin (hellebrigenin-3-O-suberate-arginine)



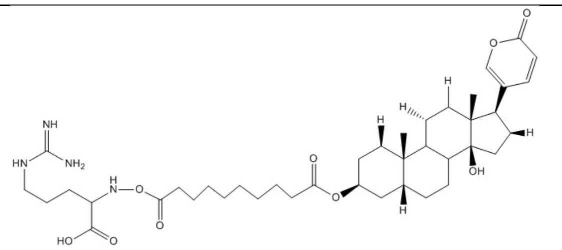
**(93)** bufotoxin



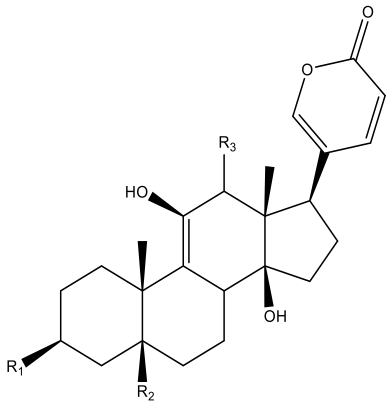
**(94)** 3β,14β,19β-trihydroxybufa-20,22-dienolide; 3-O-suberate-L-histidine



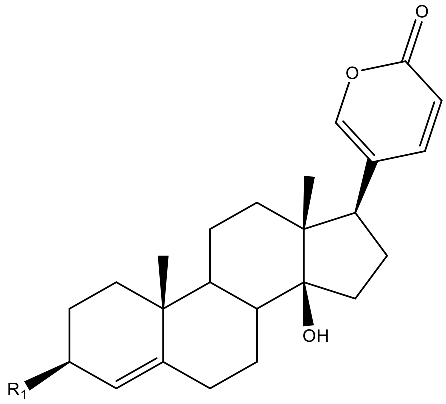
**(95)** gamabufotalin-3-O-pelargonate-arginine



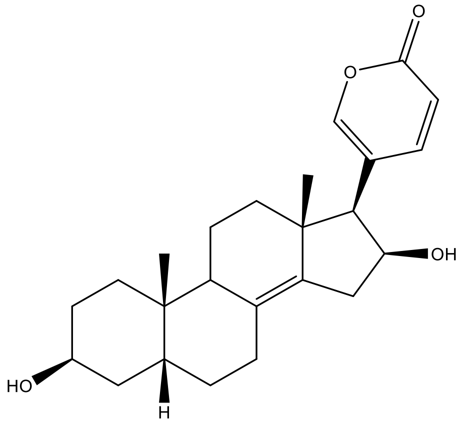
**(96)** bufalin-3-O-sebacate-arginine



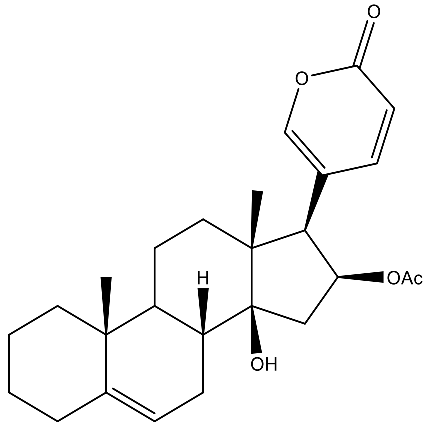

| Compound | R1 | R2 | R3 | PubChem | Ref. |
|---|---|---|---|---|---|
| **(97)** argentinogenin | OH | H | =O | 12305202 | [10] |
| **(98)** argentinogenin-3-O-adipate-arginine | $OCO(CH_2)_4COArg$ | H | =O | | [12] |
| **(99)** hellebrigenol-9,11-ene | OH | OH | H | | [12] |




| Compound | R1 | Ref. |
|---|---|---|
| **(100)** 3-dehydroscillarenin | =O | [19] |
| **(101)** scillarenin-3-pimelate-arginine | $OCO(CH_2)_5COArg$ | [12] |
| **(102)** scillarenin-3-suberate-arginine | $OCO(CH_2)_6COArg$ | [12] |

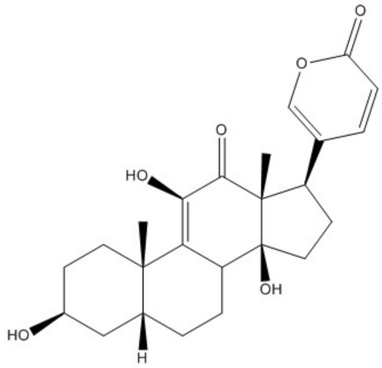
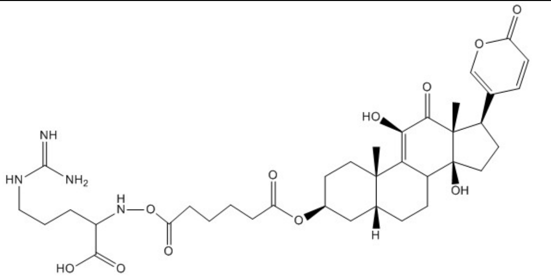
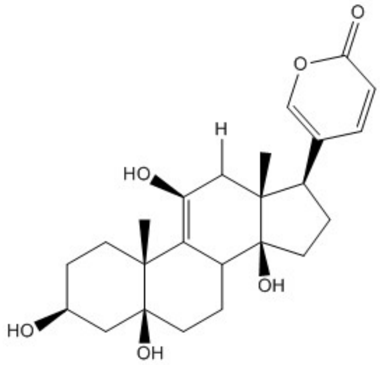
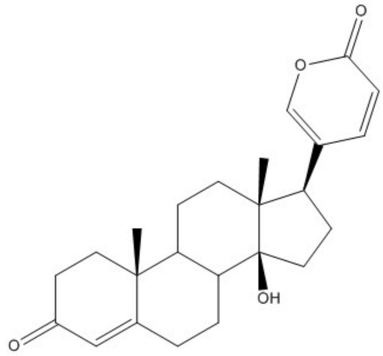
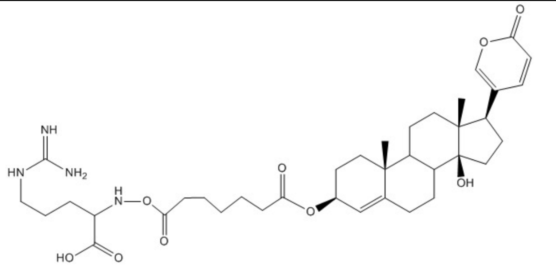
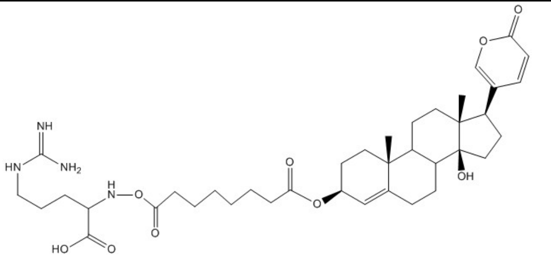
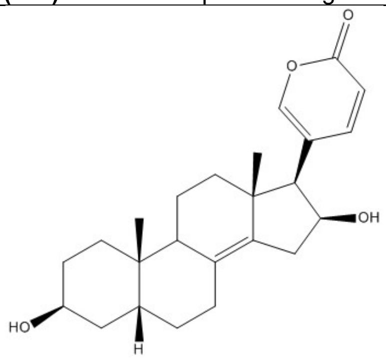
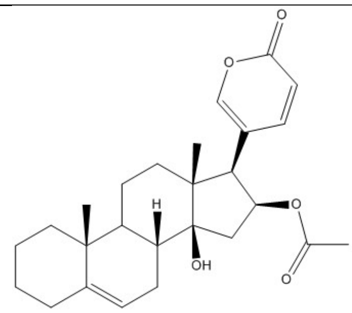



**(103)** 3β,16β-dihydroxybufa-8(14),20,22-trienolide [10]

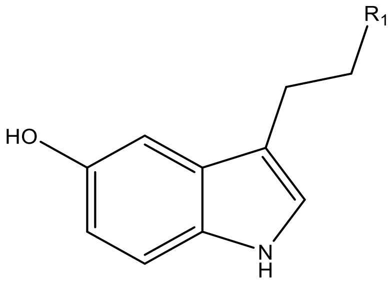



**(104)** 14,16-dihydroxybufa-5,20,22-trienolide; (14β,16β)-form, 16-Ac [10]

Figure 4. Chemical structures of other bufadienolides identified in Bufonis Venenum.

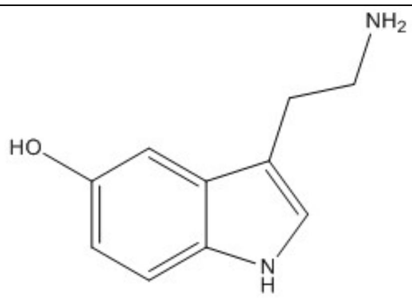
| | |
|---|---|
| <br>**(97)** argentinogenin | <br>**(98)** argentinogenin-3-O-adipate-arginine |
| <br>**(99)** hellebrigenol-9,11-ene | <br>**(100)** 3-dehydroscillarenin |
| <br>**(101)** scillarenin-3-pimelate-arginine | <br>**(102)** scillarenin-3-suberate-arginine |
| <br>**(103)** 3β,16β-dihydroxybufa-8(14),20,22-trienolide | <br>**(104)** 14,16-dihydroxybufa-5,20,22-trienolide; (14β,16β)-form, 16-Ac |

최근 연구에서는 섬수에서 bufadienolide 이외에도 **(105)** serotonin 이 포함되어 있는 것으로 알려졌다 [16, 17]. 특히, 섬수의 water extract 에서는 serotonin 이 bufadienolide 보다 최대 20 배 이상 많이 검출되었다 [16].

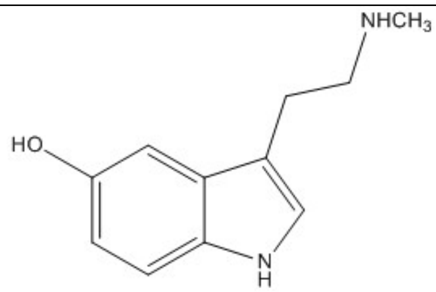



| Compound | $R_1$ | PubChem | Ref. |
|---|---|---|---|
| **(105)** serotonin | $NH_2$ | 5202 | [16, 17] |
| **(106)** N-methylserotonin | $NHCH_3$ | 150885 | [17] |

Figure 5. Chemical structure of serotonin and N-methylserotonin identified in Bufonis Venenum.




**(105)** serotonin

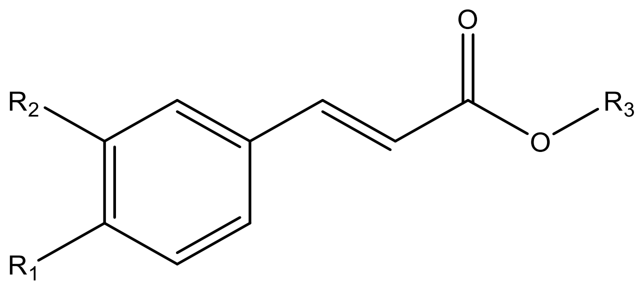


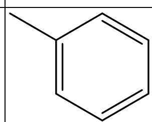
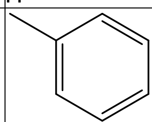
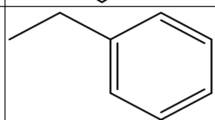
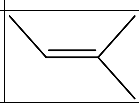

**(106)** N-methylserotonin

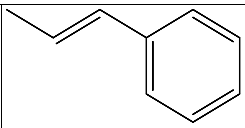
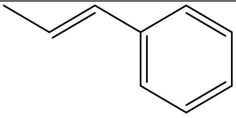
### 3.2. 봉교(蜂胶), Propolis

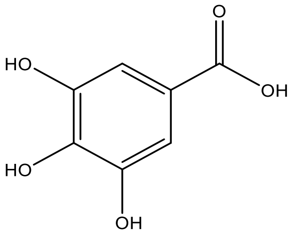
봉교(蜂胶, Propolis)는 Apidae 과에 속하는 꿀벌(*Apis mellifera* L.)이 식물의 꽃봉오리나 껍질로부터 만들어내는 천연 수지이다. 봉교는 고대부터 약재료 이용되어 왔는데, 주요 성분은 phenolic, flavonoid, glycerol ester 로 알려져 왔다. 봉교의 성분은 수집된 지역의 특정 flora 에 의해서 영향을 받는다. 이러한 이유로 여기에서는 중국, 한국, 일본 지역에서 *A. mellifera* 에 의해서 생산된 봉교의 성분들만 조사하였다.

봉교에 있는 phenolic 들은 **(119)** gallic acid 와 cinnamic acid derivative 들과 같은 phenolic acid 와 **(120)** resveratrol 와 같은 stilbenoid 를 포함하고 있다. 또한 봉교에는 phenylalkyl acid 인 **(107)** cinnamic acid 와 **(121)** cinnamylidene acetic acid 들도 존재한다. Cinnamic acid derivative 는 phenyl group 의 C-3 과 C-4 위치에 hydroxy 나 methoxy 그룹이 연결되어 있으며, ester linkage 도 가지고 있다. 이 ester 들 중에서 **(115)** caffeic acid phenethyl ester (CAPE)는 봉교의 유효 성분 중의 하나로 알려져 있다. Figure 6 은 봉교의 phenolic 들과 phenylalkyl acid 들에 대한 화학 구조이다.

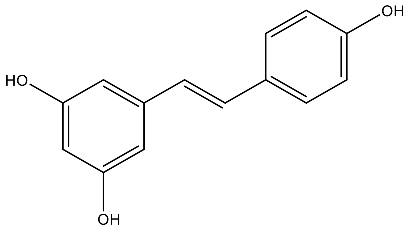


| No | Compound | $R_1$ | $R_2$ | $R_3$ | PubChem | Ref. |
|---|---|---|---|---|---|---|
| **(107)** | cinnamic acid | H | H | H | 444539 | [21-23] |
| **(108)** | 3,4-dimethoxycinnamic acid (3,4-dimethylcaffeic acid) | $OCH_3$ | $OCH_3$ | H | 1585026 | [22-30] |
| **(109)** | ferulic acid | OH | $OCH_3$ | H | 445858 | [22, 23, 26, 28-37] |
| **(110)** | isoferulic acid | $OCH_3$ | OH | H | 736186 | [23, 27-30] |
| **(111)** | p-coumaric acid | OH | H | H | 1549106 | [22-26, 28, 32, 33, 35, 36] |
| **(112)** | p-coumaric acid benzyl ester | OH | H |  | | [28] |
| **(113)** | caffeic acid | OH | OH | H | 689043 | [22-30, 32-37] |
| **(114)** | caffeic acid benzyl ester (benzyl caffeate) | OH | OH |  | 5919576 | [27-30] |
| **(115)** | caffeic acid phenethyl ester (phenethyl caffeate) | OH | OH |  | 5281787 | [23-25, 28-31, 33, 35, 37, 38] |
| **(116)** | caffeic acid isoprenyl ester | OH | OH |  | 5281790 | [28] |

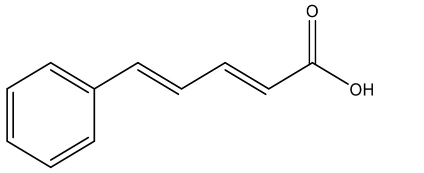
| | | | | | | |
|---|---|---|---|---|---|---|
| **(117)** | caffeic acid cinnamyl ester (cinnamyl caffeate) | OH | OH |  | | [24, 25, 28] |
| **(118)** | p-methoxycinnamic acid cinnamyl ester | $OCH_3$ | H |  | | [28] |



**(119)** gallic acid (PubChem 370) [22, 36]

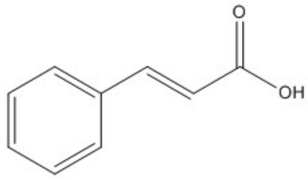


**(120)** resveratrol (PubChem 445154) [33]

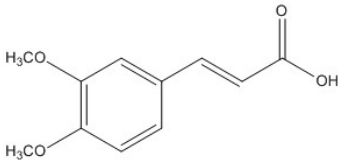


**(121)** cinnamylidene acetic acid [24, 25]

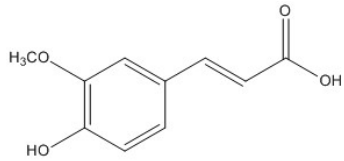
Figure 6. Chemical structures of phenolics and phenylalkyl acids identified in Propolis.



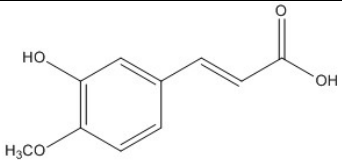
**(107)** cinnamic acid



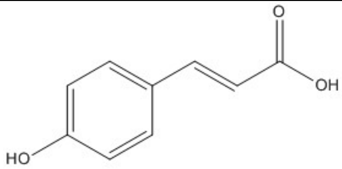
**(108)** 3,4-dimethoxycinnamic acid (3,4-dimethylcaffeic acid)



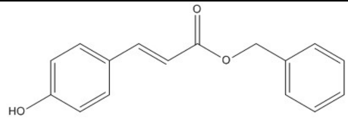
**(109)** ferulic acid



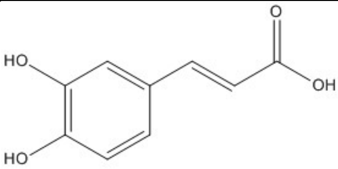
**(110)** isoferulic acid



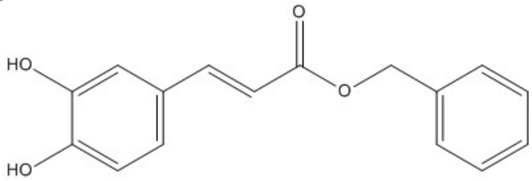
**(111)** p-coumaric acid



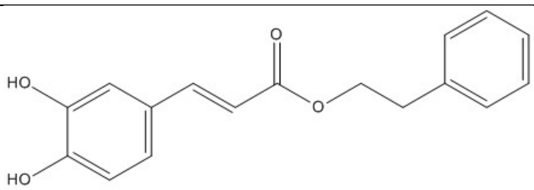
**(112)** p-coumaric acid benzyl ester



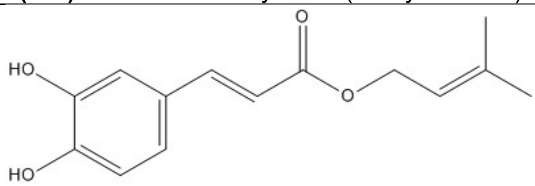
**(113)** caffeic acid



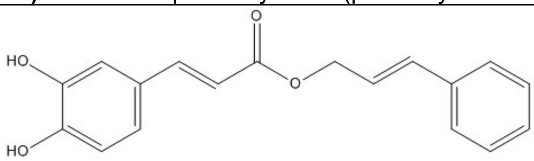
**(114)** caffeic acid benzyl ester (benzyl caffeate)



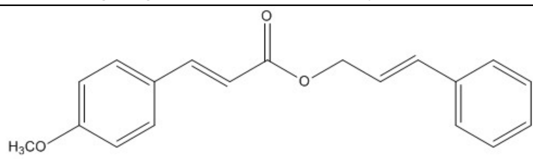
**(115)** caffeic acid phenethyl ester (phenethyl caffeate)



**(116)** caffeic acid isoprenyl ester

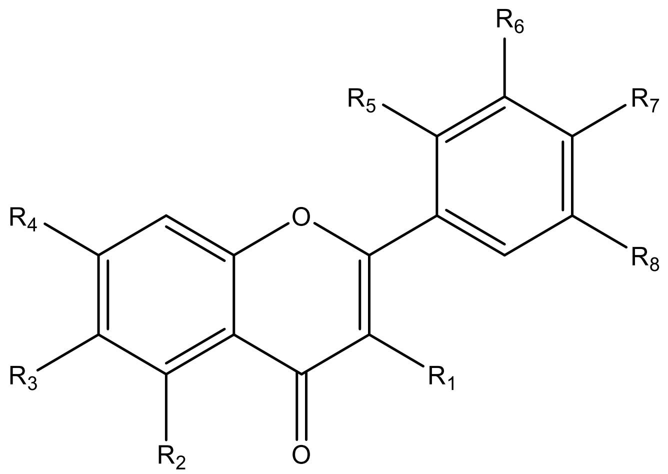


**(117)** caffeic acid cinnamyl ester (cinnamyl caffeate)



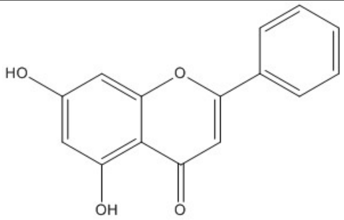
**(118)** p-methoxycinnamic acid cinnamyl ester

봉교의 flavonoid 성분은 anthocyanin, flavanone, flavan, isoflavonoid 들이 있다. Figure 7 은 anthocyanin 의 구조를 보인 것이다. Anthocyanin 은 flavone 과 flavonol 의 두 그룹으로 나눌 수 있는데, flavonol 은 flavone 에서 4H-chromene 의 C-3 position($R_1$)에 hydroxy group 을 가진다. **(128)** Baicalin 은 baicalein 의 glucuronide 이며, **(135)** rutin 은 quercetin 과 disaccharide rutinose 가 연결된 glycoside 로써, quercetin-3-O-rutinoside 로도 불린다.

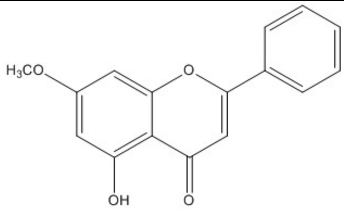



| No | Compound | $R_1$ | $R_2$ | $R_3$ | $R_4$ | $R_5$ | $R_6$ | $R_7$ | $R_8$ | PubChem | Ref. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **(122)** | chrysin | H | OH | H | OH | H | H | H | H | 5281607 | [22-31, 33-35, 37, 39-43] |
| **(123)** | tectochrysin (chrysin 7-methyl ether) | H | OH | H | $OCH_3$ | H | H | H | H | 5281954 | [24, 25, 28, 39] |
| **(124)** | apigenin | H | OH | H | OH | H | H | OH | H | 5280443 | [22-26, 28-31, 33-35, 37, 40, 42] |
| **(125)** | luteolin | H | OH | H | OH | H | OH | OH | H | 5280445 | [22, 26, 28, 34] |
| **(126)** | luteolin 5-methyl ether | H | $OCH_3$ | H | OH | H | OH | OH | H | | [28] |
| **(127)** | acacetin | H | OH | H | OH | H | H | $OCH_3$ | H | 5280442 | [26, 31] |
| **(128)** | baicalin | H | OH | OH | glucuronide | H | H | H | H | 64982 | [22] |
| **(129)** | galangin | OH | OH | H | OH | H | H | H | H | 5281616 | [23-25, 27-31, 33, 35, 37, 39-44] |
| **(130)** | galangin 5-methyl ether | OH | $OCH_3$ | H | OH | H | H | H | H | | [28] |
| **(131)** | fisetin | OH | H | H | OH | H | OH | OH | H | 5281614 | [22] |
| **(132)** | quercetin | OH | OH | H | OH | H | OH | OH | H | 5280343 | [22, 23, 25, 31, 33, 34, 37, 40, 42] |
| **(133)** | quercetin 3-methyl ether | $OCH_3$ | OH | H | OH | H | OH | OH | H | | [28] |
| **(134)** | quercetin 5,7-dimethyl ether | OH | $OCH_3$ | H | $OCH_3$ | H | OH | OH | H | | [28] |
| **(135)** | rutin | OH | OH | rutinose | OH | H | OH | OH | H | 5280805 | [22, 31, 36, 37, 40, 42] |
| **(136)** | kaempferol | OH | OH | H | OH | H | H | OH | H | 5280863 | [22-26, 31, 33, 40, 42] |
| **(137)** | isorhamnetin | OH | OH | H | OH | H | $OCH_3$ | OH | H | 5281654 | [22, 28] |
| **(138)** | kaempferide | OH | OH | H | OH | H | H | $OCH_3$ | H | 5281666 | [34] |
| **(139)** | izalpinin | OH | OH | H | $OCH_3$ | H | H | H | H | 5318691 | [39] |
| **(140)** | morin | OH | OH | H | OH | OH | H | OH | H | 5281670 | [22, 31, 34, 37] |
| **(141)** | myricetin | OH | OH | H | OH | H | OH | OH | OH | 5281672 | [22, 31, 37, 40, 42] |

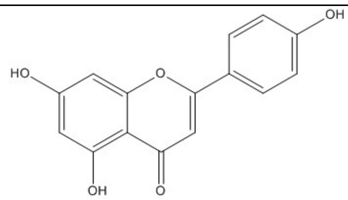
Figure 7. Chemical structures of anthoxanthins identified from Propolis.



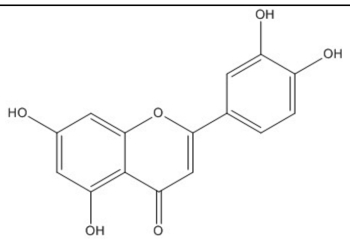
**(122)** chrysin



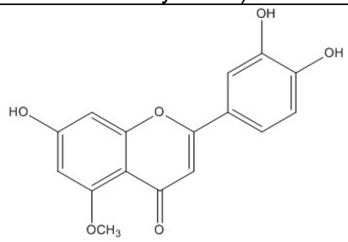
**(123)** tectochrysin (chrysin 7-methyl ether)



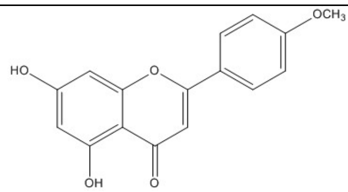
**(124)** apigenin



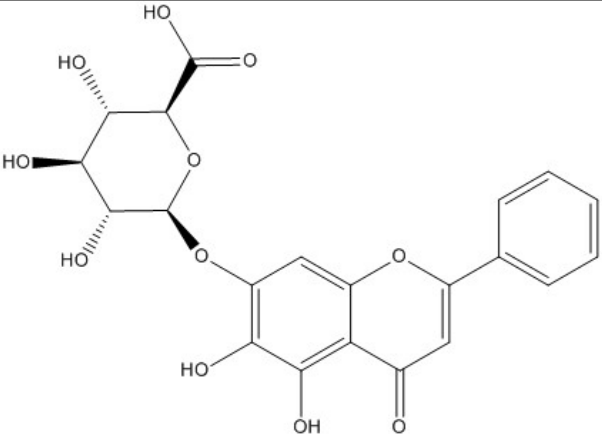
**(125)** luteolin



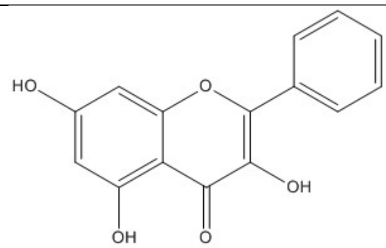
**(126)** luteolin 5-methyl ether



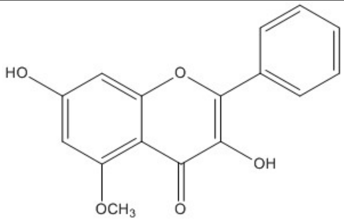
**(127)** acacetin



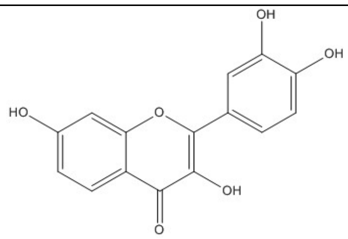
**(128)** baicalin



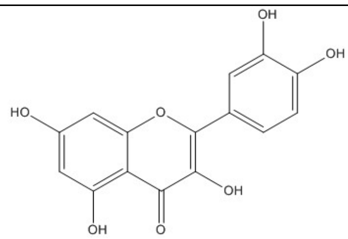
**(129)** galangin



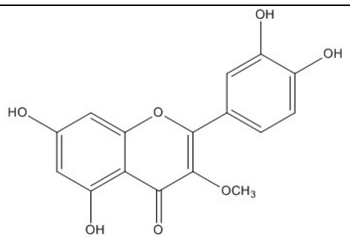
**(130)** galangin 5-methyl ether



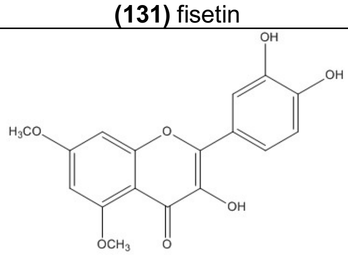
**(131)** fisetin



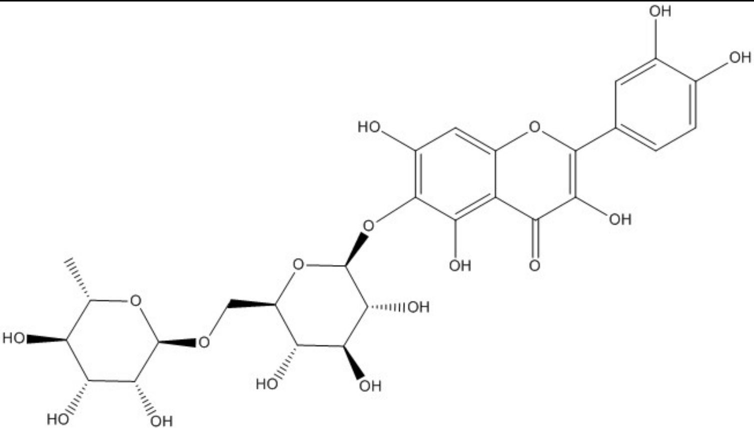
**(132)** quercetin



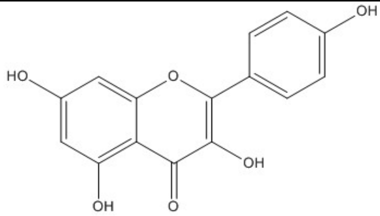
**(133)** quercetin 3-methyl ether



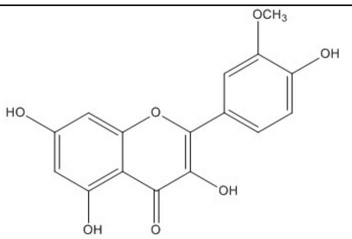
**(134)** quercetin 5,7-dimethyl ether



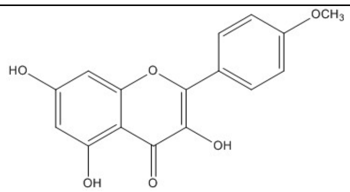
**(135)** rutin



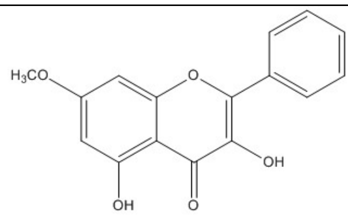
**(136)** kaempferol



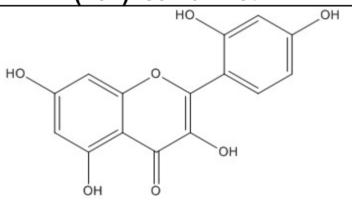
**(137)** isorhamnetin



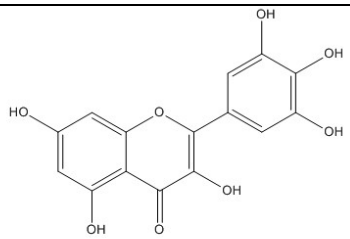
**(138)** kaempferide



**(139)** izalpinin

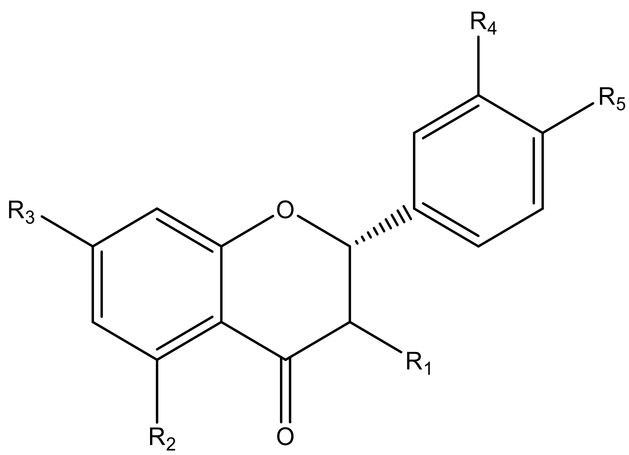


**(140)** morin



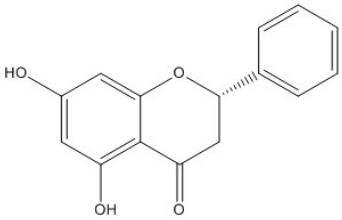
**(141)** myricetin

Figure 8 은 봉교에서 추출된 flavanone 의 화학 구조이다. 봉교에는 **(142)** pinocembrin 과 **(145)** pinobanksin 그리고 이들의 ethers, 그리고 **(154)** naringenin 과 **(155)** hesperetin 들을 포함하는 flavanone 들이 존재한다.

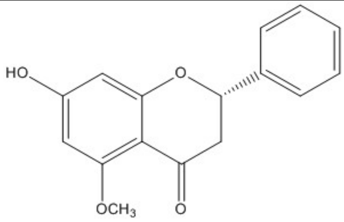



| No | Compound | $R_1$ | $R_2$ | $R_3$ | $R_4$ | $R_5$ | PubChem | Ref. |
|---|---|---|---|---|---|---|---|---|
| **(142)** | pinocembrin | H | OH | OH | H | H | 667544 | [22-25, 27-33, 35, 37, 39, 40, 43] |
| **(143)** | pinocembrin 5-methyl ether | H | $OCH_3$ | OH | H | H | | [28] |
| **(144)** | pinocembrin 7-methyl ether (pinostrobin) | H | OH | $OCH_3$ | H | H | 73201 | [28, 39] |
| **(145)** | pinobanksin | OH | OH | OH | H | H | 73202 | [23-25, 28-30, 43] |
| **(146)** | pinobanksin 5-methyl ether | OH | $OCH_3$ | OH | H | H | | [24, 25, 27, 28] |
| **(147)** | pinobanksin 7-methyl ether | OH | OH | $OCH_3$ | H | H | | [28, 32] |
| **(148)** | pinobanksin 3-O-acetate | $OCOCH_3$ | OH | OH | H | H | | [23-26, 28, 43] |
| **(149)** | pinobanksin 3-O-propionate | $OCOC_2H_5$ | OH | OH | H | H | | [28] |
| **(150)** | pinobanksin 3-O-butyrate | $OCOC_3H_7$ | OH | OH | H | H | | [28] |
| **(151)** | pinobanksin 3-O-isobutyrate | $OCOCH(CH_3)_2$ | OH | OH | H | H | | [28] |
| **(152)** | pinobanksin 3-O-pentanoate | $OCOC_4H_9$ | OH | OH | H | H | | [28] |
| **(153)** | pinobanksin 3-O-(2-methyl) butyrate | $OCOCH(CH_3)CH_2CH_3$ | OH | OH | H | H | | [28] |
| **(154)** | naringenin | H | OH | OH | H | OH | 932 | [22, 23, 37] |
| **(155)** | hesperetin | H | OH | OH | OH | $OCH_3$ | 72281 | [21] |

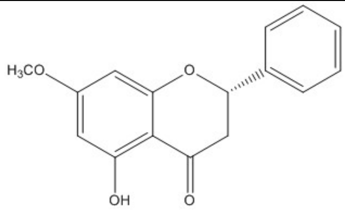
Figure 8. Chemical structures of flavanones identified from Propolis.



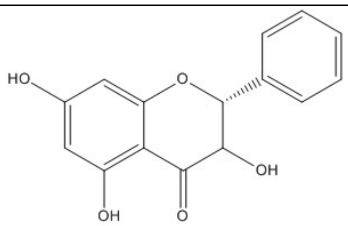
**(142)** pinocembrin



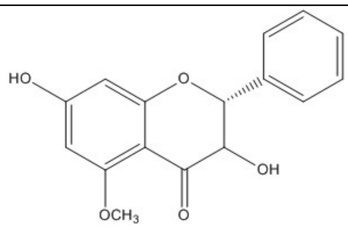
**(143)** pinocembrin 5-methyl ether



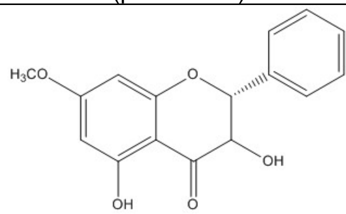
**(144)** pinocembrin 7-methyl ether (pinostrobin)



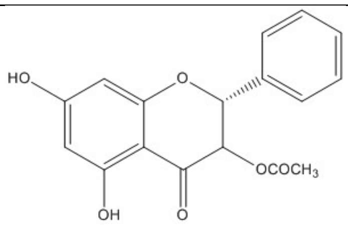
**(145)** pinobanksin



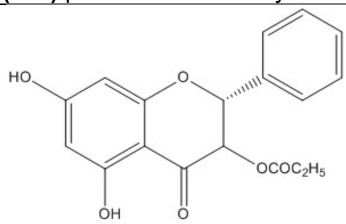
**(146)** pinobanksin 5-methyl ether



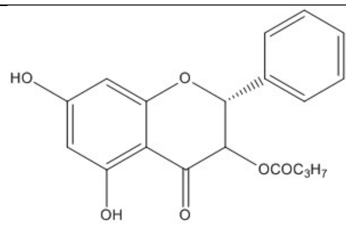
**(147)** pinobanksin 7-methyl ether



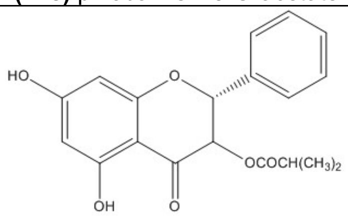
**(148)** pinobanksin 3-O-acetate



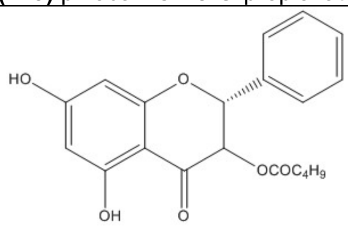
**(149)** pinobanksin 3-O-propionate



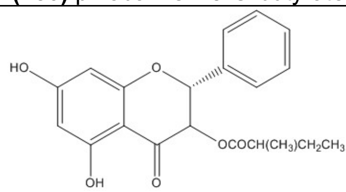
**(150)** pinobanksin 3-O-butyrate



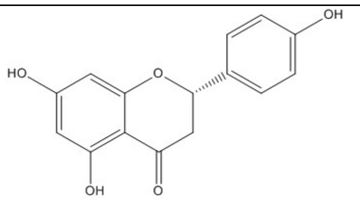
**(151)** pinobanksin 3-O-isobutyrate



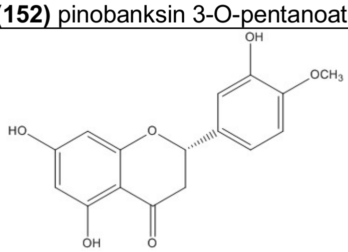
**(152)** pinobanksin 3-O-pentanoate



(153) pinobanksin 3-O-(2-methyl) butyrate

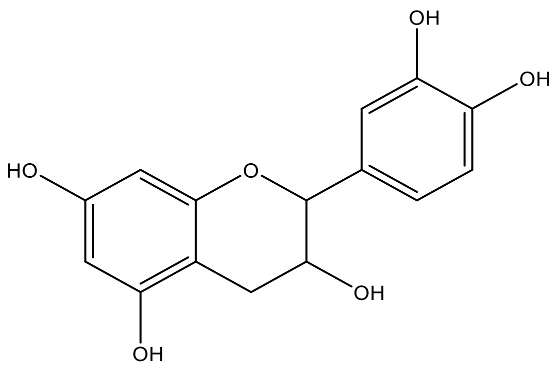


**(154)** naringenin

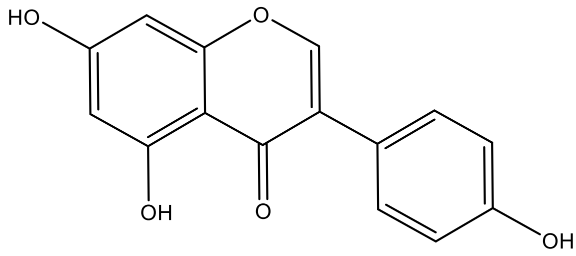


**(155)** hesperetin

봉교에 있는 flavan 은 flavanol (flavan-3-ol) 그룹에 속하는 **(156)** catechin 과 epicatechin 이 있다. Catechin 은 4H-chromene 의 C-2 와 C-3 위치에 두 개의 chiral center 가 있어서 (2R,3S), (2S,3R), (2R,3R), (2S,3S)의 네 개의 diastereoisomer 가 존재한다. 또한 봉교에는 isoflavonoid 그룹에 속하는 **(157)** genistein 이 식별되었다.



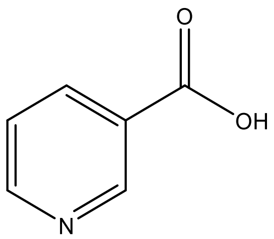
**(156)** catechin (PubChem 1203, 73160, 9064) [22]



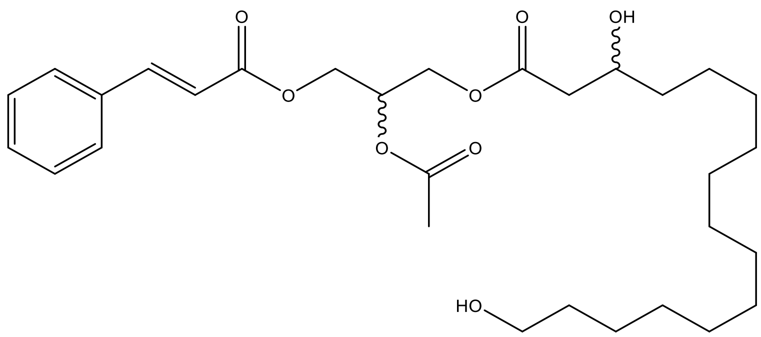
**(157)** genistein (PubChem 5280961) [22, 26]

Figure 9. Chemical structures of flavanol and isoflavonoid identified from Propolis.

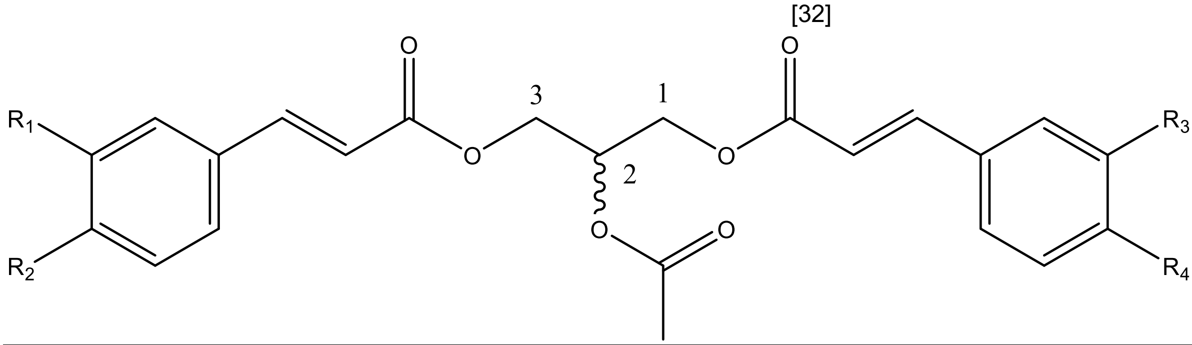
이 외에도 봉교에는 **(158)** nicotinic acid 와 glycerol ester 들도 존재하는데 이 성분들의 구조는 아래 그림과 같다.



**(158)** nicotinic acid
(PubChem 938) [21]



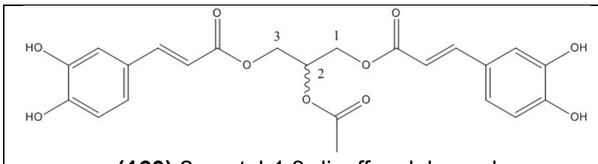
**(159)** (-)-2-acetyl-1-(E)-feruloyl-3-(3''(ζ),16'')-dihydroxy-palmitoylglycerol [32]



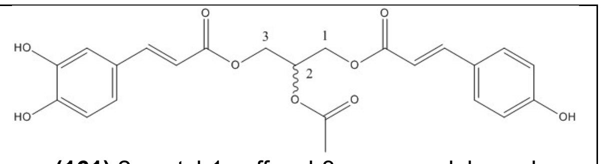
| No | Compound | $R_1$ | $R_2$ | $R_3$ | $R_4$ | Ref. |
|---|---|---|---|---|---|---|
| **(160)** | 2-acetyl-1,3-dicaffeoylglycerol | OH | OH | OH | OH | [32] |
| **(161)** | 2-acetyl-1-caffeoyl-3-coumaroylglycerol | OH | OH | H | OH | [32] |
| **(162)** | 2-acetyl-1-feruloyl-3-caffeoylglycerol | $OCH_3$ | OH | OH | OH | [32] |
| **(163)** | 2-acetyl-1-feruloyl-3-coumaroylglycerol | $OCH_3$ | OH | H | OH | [32] |
| **(164)** | 2-acetyl-1,3-diferuloylglycerol | $OCH_3$ | OH | $OCH_3$ | OH | [32] |

| | | | | | | |
|---|---|---|---|---|---|---|
| **(165)** | (-)-2-acetyl-1-caffeoyl-3-cinnamoylglycerol | OH | OH | H | H | [32] |
| **(166)** | (+)-2-acetyl-1-caffeoyl-3-cinnamoylglycerol | OH | OH | H | H | [32] |
| **(167)** | 2-acetyl-1-coumaroyl-3-cinnamoylglycerol | H | H | H | OH | [32] |
| **(168)** | (+)-2-acetyl-1-feruloyl-3-cinnamoylglycerol | H | H | $OCH_3$ | OH | [32] |
| **(169)** | (-)-2-acetyl-1-feruloyl-3-cinnamoylglycerol | H | H | $OCH_3$ | OH | [32] |
| **(170)** | 2-acetyl-1,3-dicinnamoylglycerol | H | H | H | H | [32] |

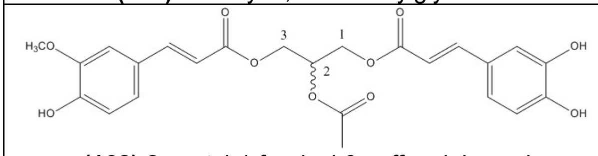
Figure 10. Chemical structures of nicotinic acid and glycerol esters identified from Propolis.



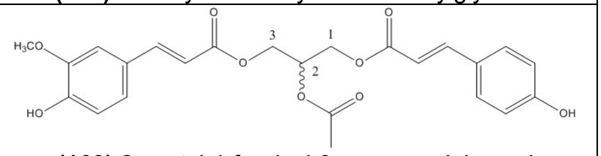
**(160)** 2-acetyl-1,3-dicaffeoylglycerol



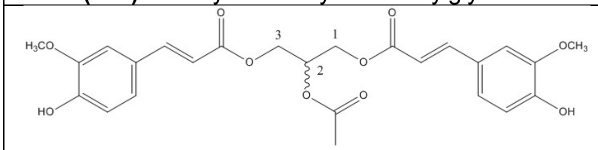
**(161)** 2-acetyl-1-caffeoyl-3-coumaroylglycerol



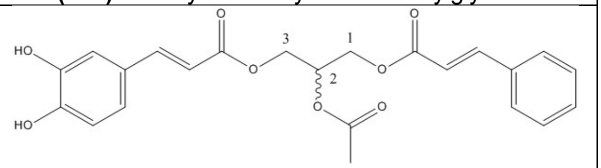
**(162)** 2-acetyl-1-feruloyl-3-caffeoylglycerol



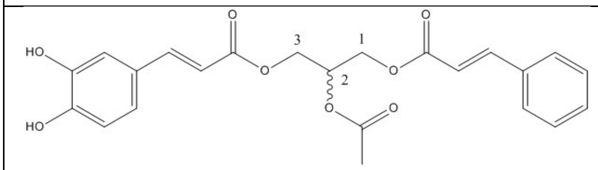
**(163)** 2-acetyl-1-feruloyl-3-coumaroylglycerol



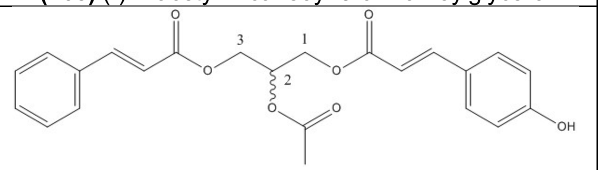
**(164)** 2-acetyl-1,3-diferuloylglycerol



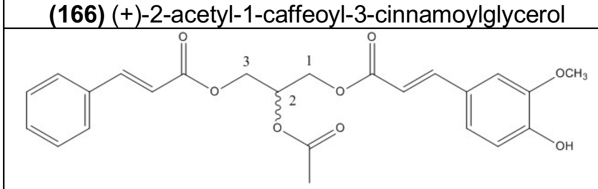
**(165)** (-)-2-acetyl-1-caffeoyl-3-cinnamoylglycerol



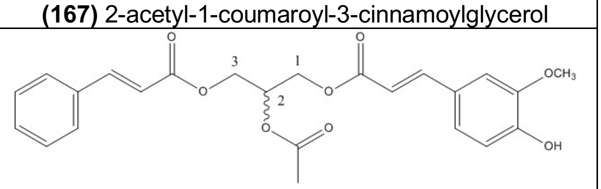
**(166)** (+)-2-acetyl-1-caffeoyl-3-cinnamoylglycerol



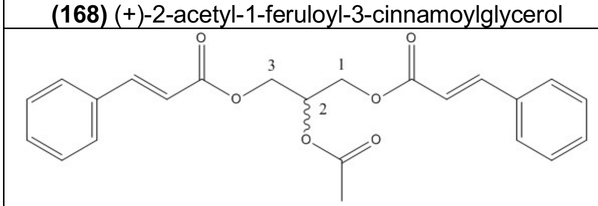
**(167)** 2-acetyl-1-coumaroyl-3-cinnamoylglycerol



**(168)** (+)-2-acetyl-1-feruloyl-3-cinnamoylglycerol



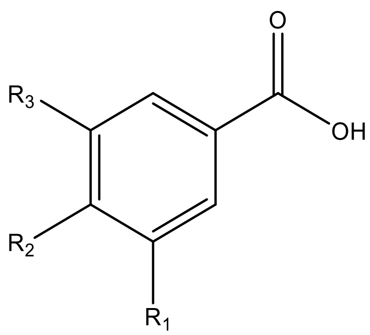
**(169)** (-)-2-acetyl-1-feruloyl-3-cinnamoylglycerol



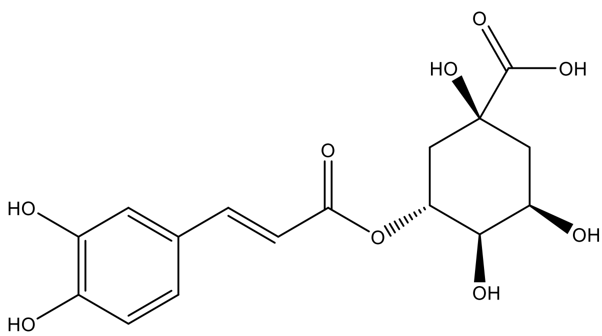
**(170)** 2-acetyl-1,3-dicinnamoylglycerol

### 3.3. 봉밀(蜂蜜), Mel

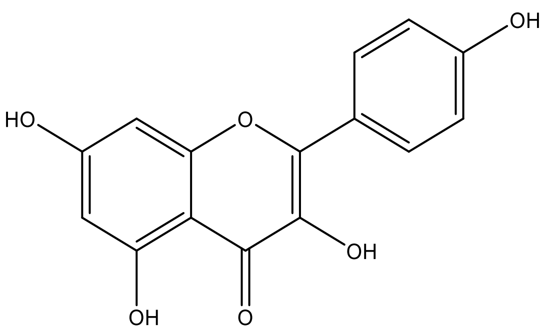
봉밀(蜂蜜, Mel, Honey)은 Apidae 과에 속하는 꿀벌(*Apis mellifera* L., *Apis cerana* Fabricus)이 식물의 nectar 와 honeydew 로부터 모은 sugary food substance 이다. 봉밀의 주요 성분은 saccharide 로써 monosaccharide (glucose and fructose), disaccharide, oligosaccharide 들로 구성된다 [45]. 또한, 봉밀은 phenolic, flavonoid, amino acid, enzyme, mineral, vitamin 들을 포함하는 것으로 알려져 있다[36, 37]. 봉교의 경우와 마찬가지로 봉밀의 구성 성분은 중국, 한국, 일본에서 *A. mellifera* 와 *A. cerana* 에 의해서 만들어진 봉밀에 대해서만 조사하였다. 하지만 PubMed 에서 검색된 대부분의 봉밀에 대한 연구들은 유럽이나 오스트레일리아 지역의 봉밀에 대한 연구들이었으며, 몇몇 연구들에서만 중국 봉밀에 대한 연구들이 이루어졌다[36, 37]. 이 연구들에서는 중국 봉밀에서 9 개의 phenolic 과 10 개의 flavonoid 들을 식별하였으며, 이들 중에서 **(113)** caffeic acid, **(109)** ferulic acid, **(111)** p-coumaric acid, **(115)** caffeic acid phenethyl ester (CAPE), **(119)** gallic acid 의 phenolic 들과 **(122)** chrysin, **(124)** apigenin, **(129)** galangin, **(132)** quercetin, **(135)** rutin, **(140)** morin, **(141)** myricetin, **(142)** pinocembrin, **(154)** naringenin 의 flavonoid 들은 봉교에도 존재하는 것이다. 이 외에 4 개의 phenolic 과 1 개의 flavonoid 에 대한 화학 구조식은 아래와 같다.




| Compound | $R_1$ | $R_2$ | $R_3$ | PubChem | Ref. |
|---|---|---|---|---|---|
| **(171)** protocatechuic acid | H | OH | OH | 72 | [36] |
| **(172)** p-hydroxybenzoic acid | H | OH | H | 135 | [36] |
| **(173)** syringic acid | $OCH_3$ | OH | $OCH_3$ | 10742 | [36] |

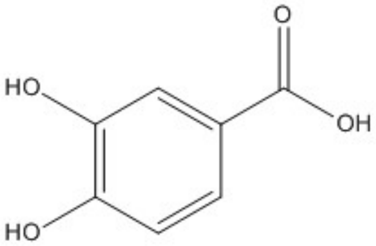
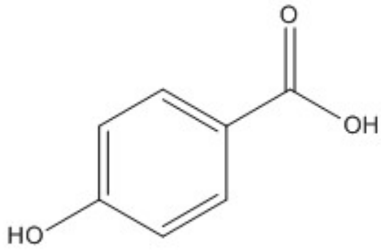
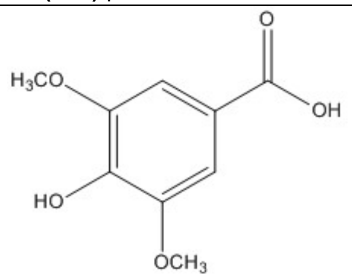



**(174)** chlorogenic acid (PubChem 1794427) [36]




**(175)** kampferol (PubChem 5280863) [37]

Figure 11. Chemical structures of phenolics and flavonoids identified from Mel.

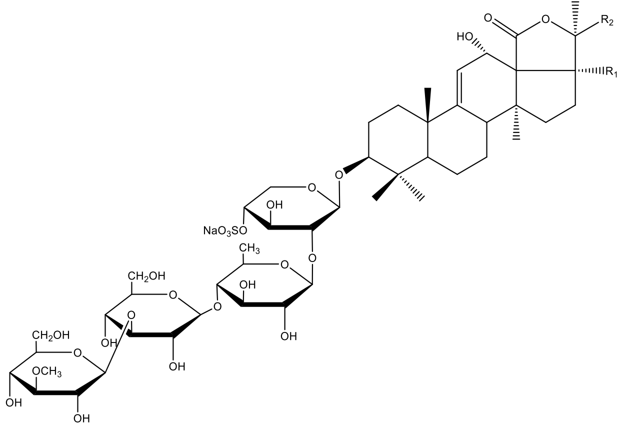
| | |
|---|---|
|  **(171)** protocatechuic acid |  **(172)** p-hydroxybenzoic acid |
|  **(173)** syringic acid | |

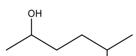
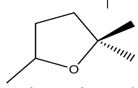
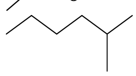
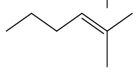
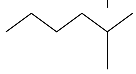
이 외에 4 개의 식물(linden, acacia, vitex and rape)들에서 수집된 중국 봉밀들 간에 **(176)** Asp, **(177)** Glu, **(178)** Ser, **(179)** Gln, **(180)** His, **(181)** Gly, **(182)** Thr, **(183)** Arg, **(184)** Ala, **(185)** Tyr, **(186)** Val, **(187)** Met, **(188)** Trp, **(189)** Phe, **(190)** Ile, **(191)** Leu, **(192)** Lys, **(193)** Pro 의 amino acid 양을 비교하는 연구가 있었다[46].

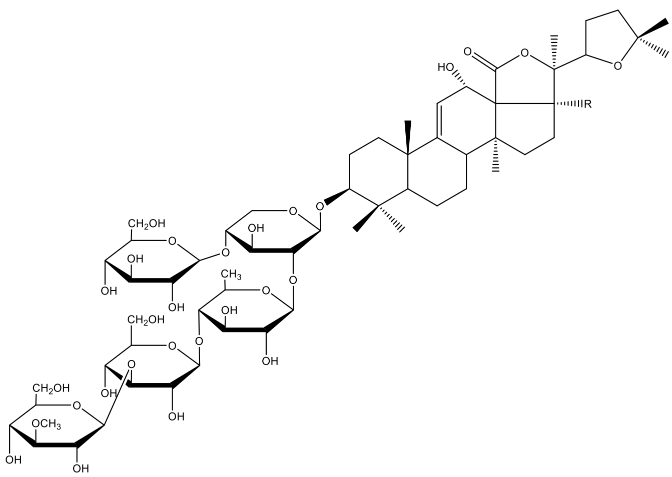
## 3.4. 해삼(海蔘), Stichopus

해삼(海蔘, Stichopus, Sea cucumber)은 Stichopodidae 과의 극피 동물이다. 한국 약전에서 해삼은 *Apostichopus japonicus* Selenka (*Stichopus japonicus* Selenka)의 몸체 벽이 약으로 이용된다고 기술되어 있으며, 중국을 포함한 아시아 지역에서는 수 천년 동안 몸에 좋은 음식으로 섭취되어 왔다. 해삼의 체벽에는 triterpene glycoside [47-49], glycosaminoglycan [50-52], cerebroside [53, 54], ganglioside [55], protein [56-58]과 같은 다양한 종류의 유효 성분들을 포함하고 있다.

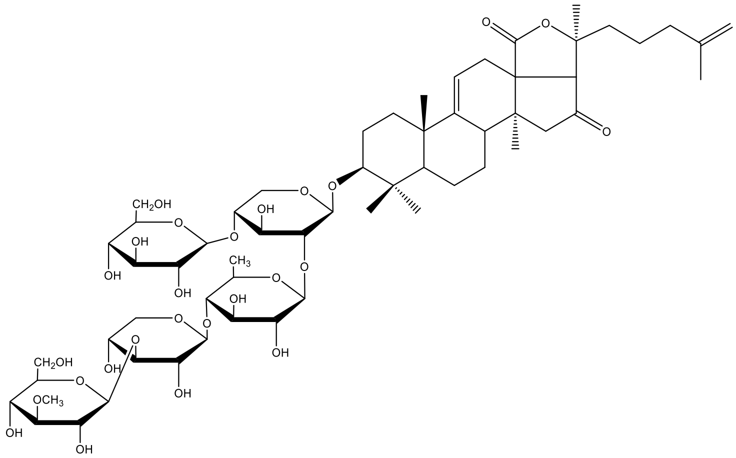
이 성분들 중에서 triterpene glycoside 는 해삼에서 가장 중요한 secondary metabolite 이다. 그 동안 Aspidochirotida 목의 Stichopodidae 과와 Dendrochirotida 목의 Cucumariidae 과에 속해 있는 여러 종의 해삼들에 대해서 수 백 개의 triterpene glycoside 들이 발견되었는데, *A. japonicus* 에서는 다음 그림과 같은 17 개의 triterpene glycoside 들이 존재한다. 모든 triterpene glycoside 들은 C18(20) lactone 그룹과 Δ7(8) 또는 Δ9(11) 이중 연결이 있는 holostane-type aglycone 을 가지며, aglycone 의 C-3 위치에 최대 6 개의 monosaccharide 가 공유 결합되어 있다.



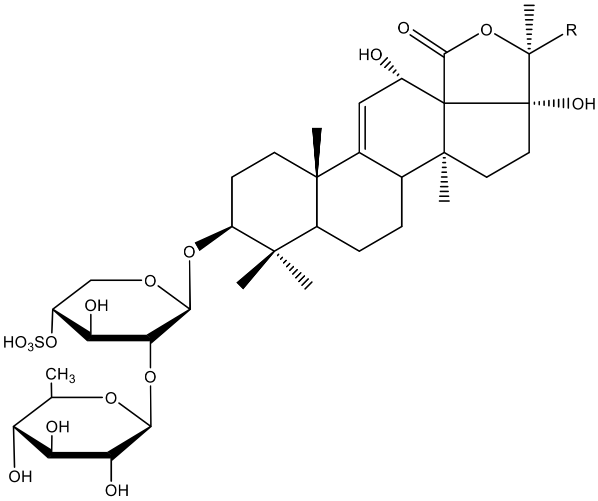

| Compound | $R_1$ | $R_2$ | PubChem | Ref. |
|---|---|---|---|---|
| **(194)** holothurin A1 | OH |  | 102057279 | [49] |
| **(195)** holothurin A | OH |  | 44559168 | [49] |
| **(196)** echinoside A | OH |  | 156831 | [49] |
| **(197)** 24-dehydro echinoside A | OH |  | | [49] |
| **(198)** pervicoside C | H |  | | [49] |

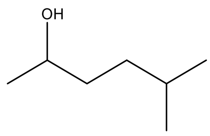
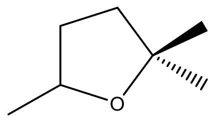


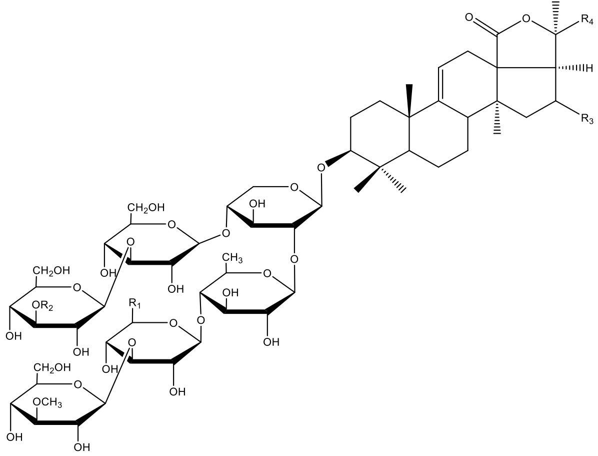

| Compound | R | Ref. |
|---|---|---|
| **(199)** holothurinoside A | OH | [49] |
| **(200)** 17-dehydroxyholothurinoside A | H | [49] |

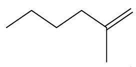
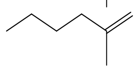
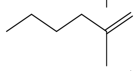
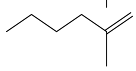
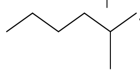


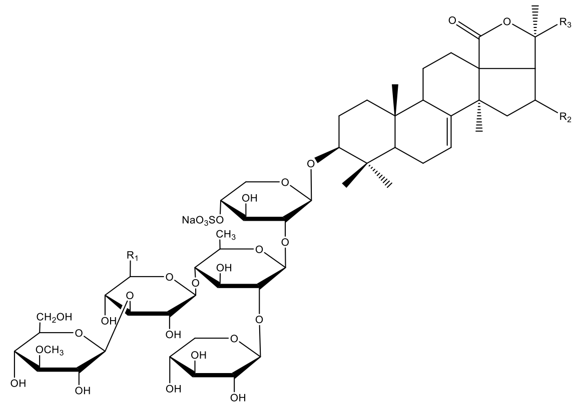

**(201)** cladoloside B (PubChem 102450455) [49]




| Compound | R | PubChem | Ref. |
| --- | --- | --- | --- |
| **(202)** holothurin B2 |  | | [49] |
| **(203)** holothurin B |  | 23674754 | [49] |




| Compound | $R_1$ | $R_2$ | $R_3$ | $R_4$ | PubChem | Ref. |
| --- | --- | --- | --- | --- | --- | --- |
| **(204)** holotoxin A | $CH_2OH$ | $CH_3$ | =O |  | 101610322 | [47] |
| **(205)** holotoxin B | $CH_2OH$ | H | =O |  | 101610323 | [47] |
| **(206)** holotoxin $A_1$ | H | $CH_3$ | =O |  | 119551 | [47-49] |
| **(207)** holotoxin $B_1$ | H | H | =O |  | | [47, 48] |
| **(208)** bivittoside C | $CH_2OH$ | H | H |  | 157055 | [49] |



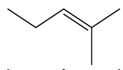
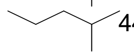
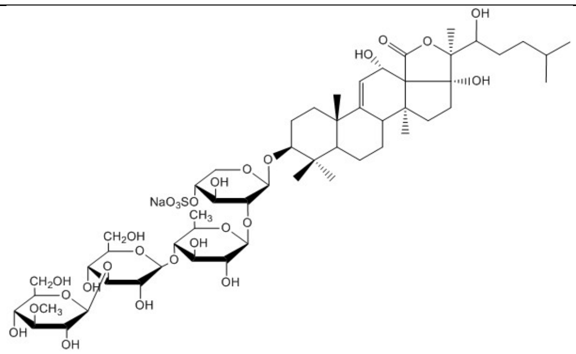
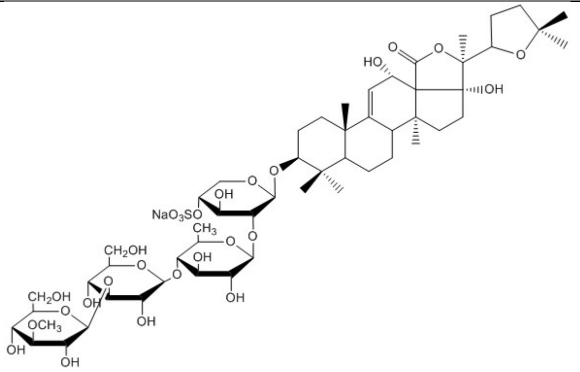
| Compound | $R_1$ | $R_2$ | $R_3$ | PubChem Ref. |
| --- | --- | --- | --- | --- |
| **(209)** frondoside $A_2$ | $CH_2OH$ | =O |  | [49] |
| **(210)** frondoside A | H | β-OAc |  | 44448161 [49] |

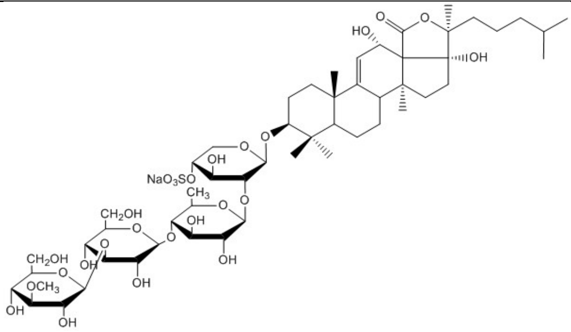
Figure 12. Chemical structures of triterpene identified from Stichopus.



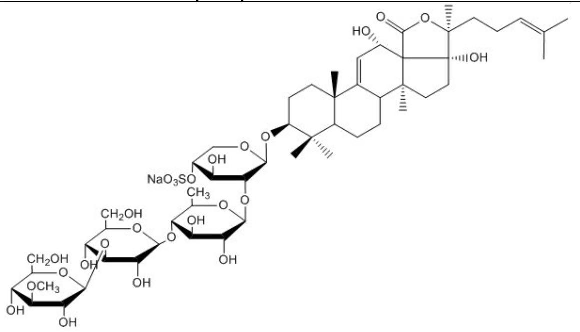
**(194)** holothurin A1



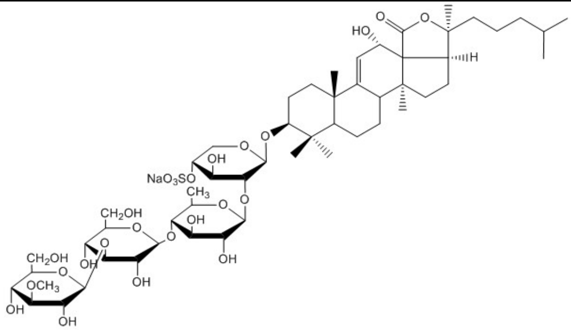
**(195)** holothurin A



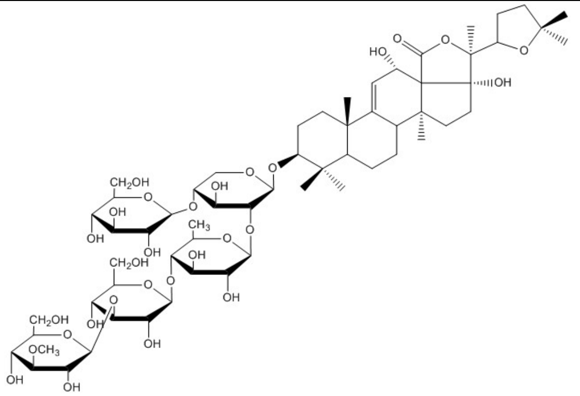
**(196)** echinoside A



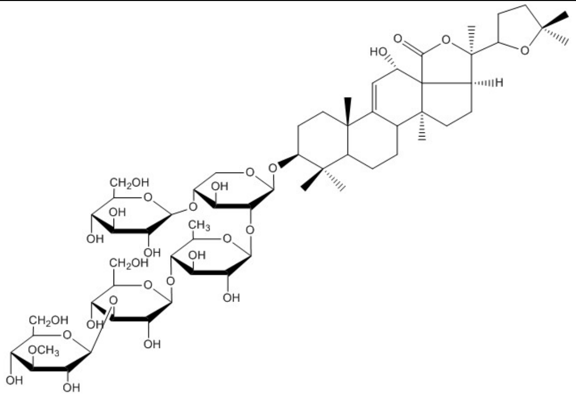
**(197)** 24-dehydroechinoside A



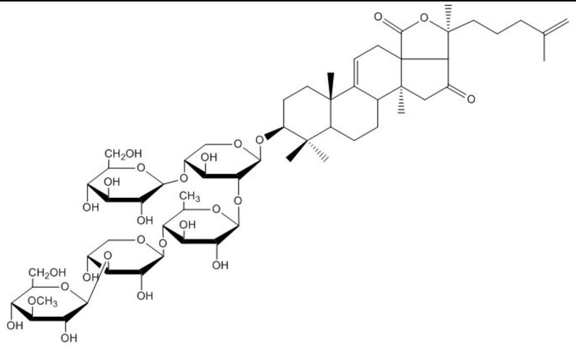
**(198)** pervicoside C



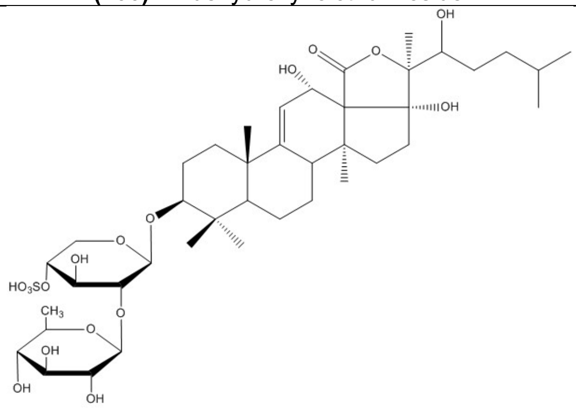
**(199)** holothurinoside A



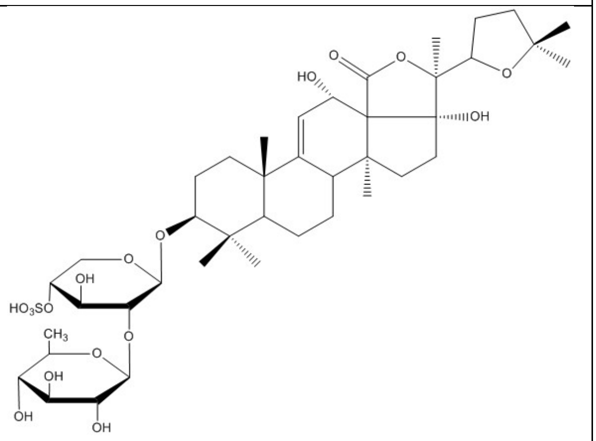
**(200)** 17-dehydroxyholothurinoside A



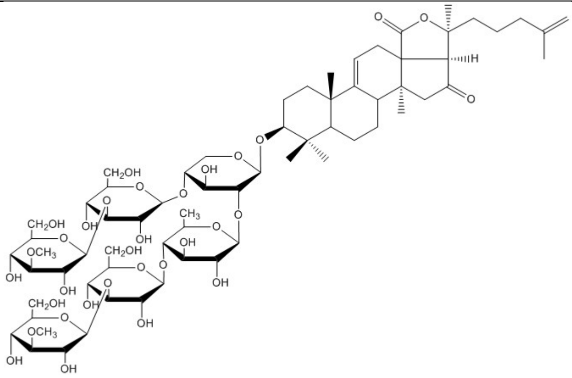
**(201)** cladoloside B



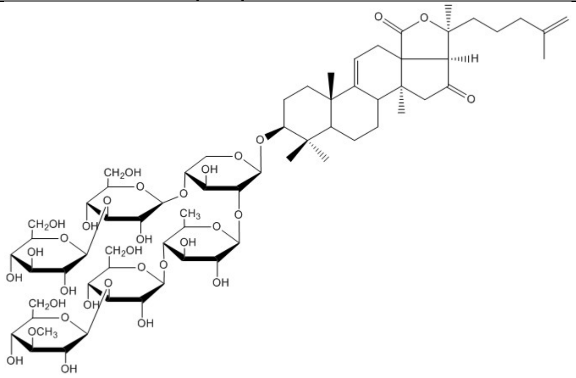
**(202)** holothurin B2



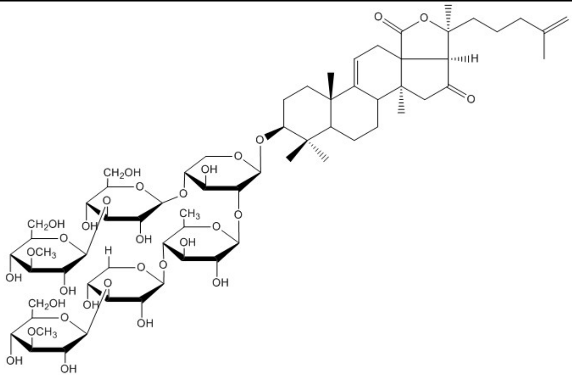
**(203)** holothurin B



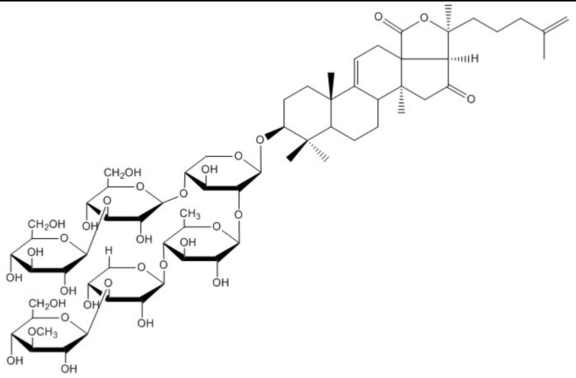
**(204)** holotoxin A



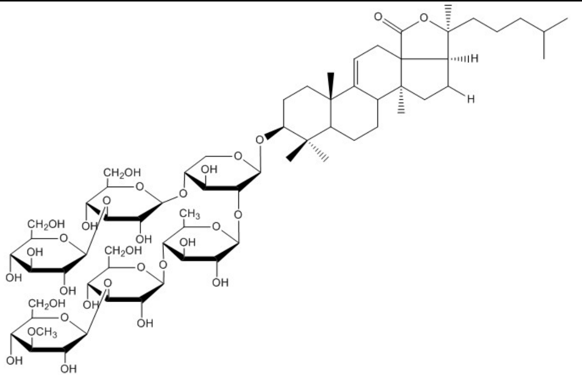
**(205)** holotoxin B



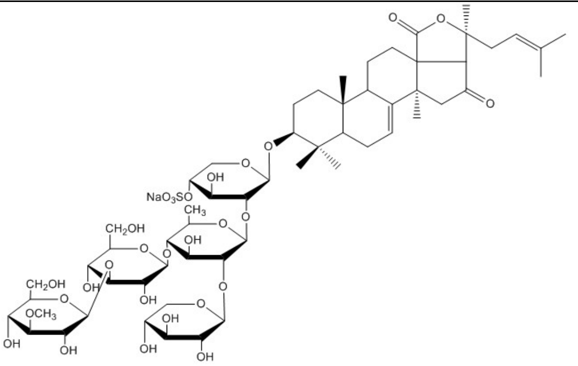
**(206)** holotoxin A1



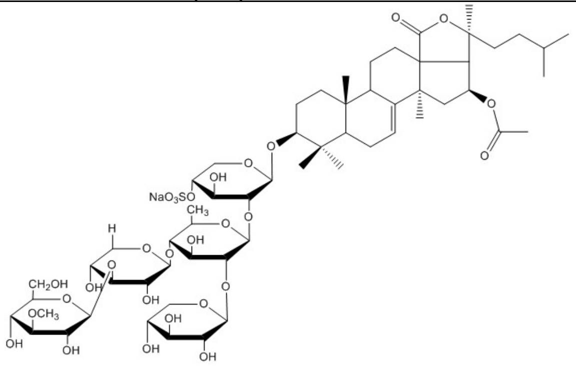
**(207)** holotoxin B1



**(208)** bivittoside C



**(209)** frondoside A2



**(210)** frondoside A

해삼의 glycosaminoglycan 은 chondroitin sulfate 의 disaccharide unit 이 반복되어 구성되는 linear polysaccharide 구조를 가진다. Chondroitin sulfate 는 glucuronic acid (GlcA)와 C-4 과 C-6 위치에 sulfate 가 있는 N-acetylgalactosamine (GalNAc)들로 구성되며, GlcA 의 C-3 위치나 GlaNAc 의 C-4 and/or C-6 위치에서 sulfated fucose branch 들과 글리코시드 결합이 존재한다. 이러한 chondroitin sulfate 의 fucosylation 의 형태는 holothurian 종마다 다른데, *A. japonicus* 은 아래 그림과 같이 fucose 가지에서 6 개 타입의 sulfate 패턴을 보인다. [$R_1$, $R_2$, $R_3$] = [$SO_3H$, $SO_3H$, H], [$SO_3H$, H, H], [H, $SO_3H$, H], [$SO_3H$, $SO_3H$, $SO_3H$], [$SO_3H$, H, $SO_3H$], and [H, $SO_3H$, $SO_3H$] [51].

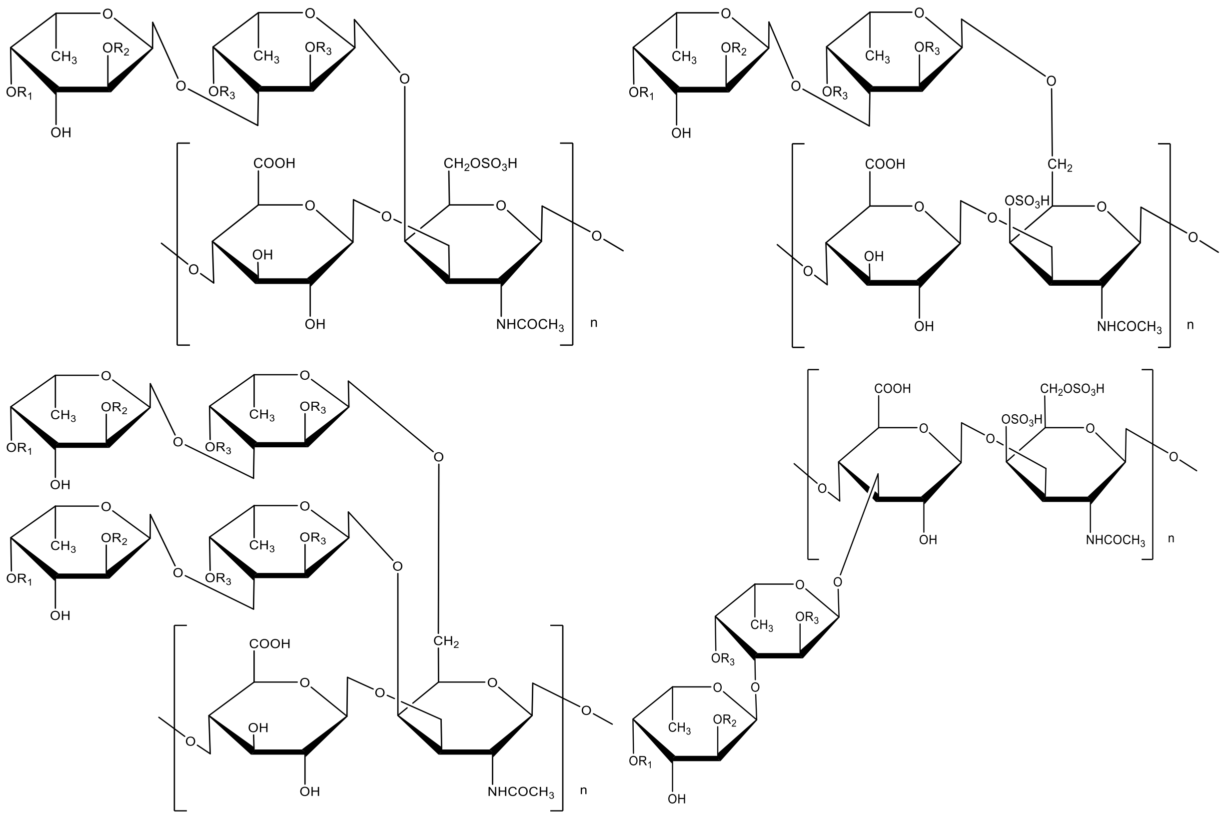


Figure 13. Chemical structures of **(211)** fucosylated chondroitin sulfate identified from Stichopus.

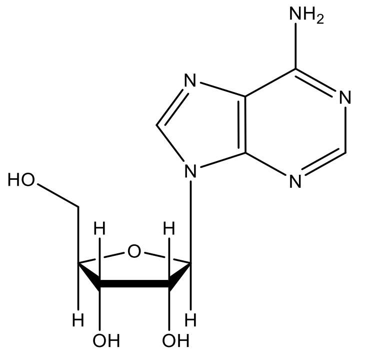
Cerebroside 와 ganglioside 는 식물, 동물, 해양생물들에서 발견되는 glycosphingolipid 들이다. Cerebroside 는 sphingoid base, fatty acid, monosaccharide 들로 구성되어 있다. 여기에서 fatty acid 는 amide bond 를 통해 sphingoid base 에 연결되며, sphingoid base 의 1-hydroxyl moiety 에 glucose 나 galactose 중 하나의 monosaccharide 가 연결된다. Cerebroside 는 sphingoid base 와 fatty acid 의 chain length, saturation, hydroxylation 의 차이에 따라서 종류가 다양하다. 해삼에서 발견된 sphingoid base 와 fatty base 들의 종류는 아래의 표와 같다.

Table 3. **(212)** Cerebrosides identified from Stichopus.

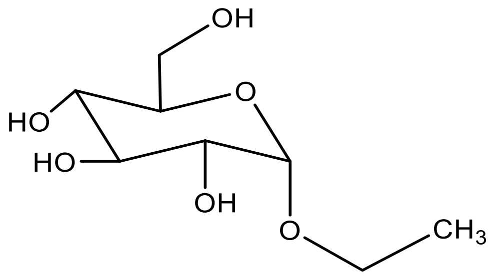
| Sphingoid base | Fatty acid | Ref. |
|---|---|---|
| 2-amino-1,3,4-trihydroxy-4-hexadecene (t16:0) | C24:1 | [53] |
| 2-amino-1,3-dihydroxy-4-hexadecene (d16:1) | C23:1, C24:0, C24:1, C25:0 | [53, 54] |
| 2-amino-1,3-dihydroxy-4,8-hexadecadiene (d16:2) | C25:0 | [54] |
| 2-amino-1,3-dihydroxy-4-heptadecene (d17:1) | C18:0, C20:0, C22:0, C22:1, C23:0, C23:1, C24:0, C24:1, C25:0 | [53, 54] |
| sphingosine (4-sphingenine, d18:1) | C18:0, C21:0, C22:0, C24:0, C24:1, C25:0 | [53, 54] |
| 4,8-sphingadienine (d18:2) | C18:0, C23:0, C24:0, C24:1, C25:0 | [53, 54] |
| 2-amino-1,3-dihydroxy-4,8,10-octadecatriene (d18:3) | C18:0, C20:0, C22:0, C22:1, C23:1, C24:1 | [53] |
| 2-amino-1,3-dihydroxy-4-nonanedecene (d19:1) | C18:0, C22:0, C23:0, C24:0, C24:1, C25:0 | [53, 54] |
| 9-methyl-4,8-sphingadienine (d19:2) | C18:0, C24:1, C25:0 | [53, 54] |
| 2-amino-1,3-dihydroxy-9-methyl-4,8,10-octadecatriene (d19:3) | C18:0, C22:0, C22:1, C23:1, C24:1 | [53] |
| 2-amino-1,3-dihydroxy-4,8,10-icosadecatriene (d20:3) | C18:0 | [53] |

Cerebroside 에는 monosaccharide 가 연결되는 반면에, ganglioside 는 1-hydroxyl moiety 에 oligosaccharide 가 연결되고, 이 oligosaccharide 에 하나 이상의 sialic acid 가 연결된 것이다. Cong et al. [55] 은 해삼에 존재하는 **(213)** ganglioside 에 대해 연구하였다.

해삼의 체벽에서 주요 영양 성분은 protein 이다. 최근 해삼의 체벽에 있는 protein 에 대한 연구가 수행되었다. Wu et al. [56] 은 해삼의 체벽에서 noncollagenous protein 인 **(214)** major yolk protein 과 **(215)** actin 가 존재함을 보였다. Xia et al. [57] 은 proteomic analysis 의 한 방법인 iTRAQ 분석을 이용해서 **(216)** melanotransferrin, **(217)** complement component3-2, **(218)** arginine kinase, **(219)** heat shock protein gp 96, **(220)** heat shock protein 90, **(221)** translation elongation factor, **(222)** myosin heavy chain, striated muscle-like isoform3, **(223)** spectrin alphachain, **(224)** peroxiredoxin-6, **(225)** proprotein convertase subtilisin/kexin type9, **(226)** 60S ribosomal protein L32e, **(227)** cathepsin L-associated protein, **(228)** 40S ribosomal protein S3-like, **(229)** aldehyde dehydrogenase,mitochondrial-like, **(230)** neurobeachin-like, **(231)** alpha-centractin-like 와 같이 16 개의 protein 을 식별하였다. Husni et al. [58]은 해삼의 체벽에서 **(232)** adenosine 과 **(233)** ethyl-α-D-glucopyranoside 을 추출하였으며 이 protein 이 tyrosinase inhibitor 로 작용하는 것을 보였다.




**(232)** adenosine




**(233)** ethyl-α-D-glucopyranoside

Figure 14. Chemical structures of adenosine and ethyl-α-D-glucopyranoside.

이 외에도 Lee et al. [59]은 건조 해삼에서 alkane, alkene, amine, amide, imide, acid, aldehyde, alcohol, ester, ketone 등을 포함한 53개의 volatile organic compound와 15개의 inorganic element를 식별하였다.

### 3.5. 우황(牛黃), Bovis Calculus, 인공우황(人工牛黄), Bovis Calculus Artifactus, 체외배육우황(体外培育牛黄), Bovis Calculus Sativus, 우담(牛膽), Bovis Fel, 웅담(熊膽), Ursi Fel, 저담(猪膽), Suis Fellis Pulvis, 사담(蛇膽), Serpentis Fel

전통 의학에서는 오래 전부터 소, 돼지, 곰, 뱀과 같은 동물의 담석이나 담즙을 약재로 이용해왔다. 이 약재들에서 유효 성분은 bile acid 인데, 최근 약재별로 어떤 bile acid 들을 얼마나 가지고 있는지에 대한 연구가 수행되어 왔다.

우황(牛黃, Bovis Calculus, cow bezoar, natural Calculus Bovis)은 Bovidae 과에 속하는 *Bos taurus domesticus* Gmelin 의 담석을 건조한 것이다. 하지만 우황은 채취되는 양이 적고 가격도 비싸기 때문에 최근에는 우황의 대체제로 인공우황(人工牛黄, Bovis Calculus Artifactus, artificial Calculus Bovis)이 개발되었다. 인공우황은 cattle bile, **(234)** cholic acid (CA), **(237)** hyodeoxycholic acid (HDCA), **(255)** taurine, **(256)** bilirubin, cholesterol 을 섞어 만든 것으로 우황에 비해 가격은 훨씬 싸지만 우황과 비슷한 효능을 보이는 것으로 알려져 있다. 또한 체외배육우황(体外培育牛黄, Bovis Calculus Sativus)도 개발되었는데, 시장에서는 인공우황이 더 많이 거래되고 있다. 다음은 우황, 인공우황, 체외배육우황에서 식별된 구성성분을 리스트한 것이다.

- 우황: cholic acid, deoxycholic acid (DCA), chenodeoxycholic acid (CDCA), hyodeoxycholic acid, ursodeoxycholic acid (UDCA), taurocholic acid (=taurocholate sodium, TCA), glycocholic acid (GCA), glycodeoxycholic acid (GDCA), glycochenodeoxycholic acid (GCDCA), taurodeoxycholic acid (TDCA), taurochenodeoxycholic acid (TCDCA), bilirubin [60-66].
- 인공우황: CA, DCA, CDCA, HDCA, UDCA, TCA, lithocholic acid (LCA), GCA, GDCA, GCDCA, glycolithocholic acid (GLCA), TDCA, taurolithocholic acid (TLCA), TCDCA, TUDCA, bilirubin, taurine [60-64, 66-71]
- 체외배육우황: CA, DCA, CDCA, HDCA, UDCA, TCA, GCA, LCA, bilirubin, 3α,12α-dihydroxy-7-oxo-5β-cholanic acid [60, 61, 63, 64]

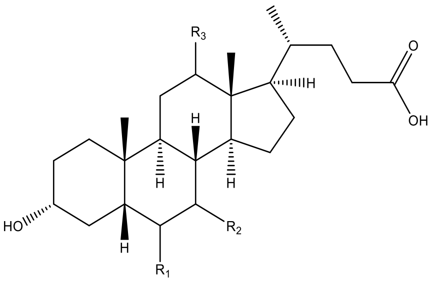
그 동안, 우황, 인공우황, 체외배육우황이 효능에 있어 어떤 차이가 있는지 규명하기 위해서 각각의 약재들에서 bile acid 들이 얼마나 차이가 나는지 분석하는 연구들이 수행되어 왔다 [60, 61, 63, 64]. 각각의 연구들에서는 약재들이 포함하는 성분과 성분의 양을 분석하였지만, 논문마다 서로 분석한

결과가 다르기 때문에 객관적으로 어떤 성분이 어떤 약재의 주요 성분이며, 약재의 효능에 중요한지 판단하기에는 현재로서는 어려운 상황이다.

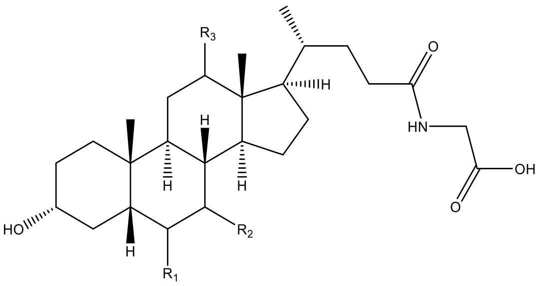
우담(牛膽, Bovis Fel)은 Bovidae 과에 속하는 소(*Bos taurus domesticus* Gmelin) 또는 물소(*Bubalus bubalis* Linne)의 쓸개를 말린 것이다. 웅담(熊膽, Ursi Fel)은 Ursidae 과에 속하는 곰(*Ursus arctos* Linne, *Selenaretos thibetanus* Cuvier)의 담즙을 말린 것이다. 사담(蛇膽, Serpentis Fel)은 Elapidae 과에 속하는 뱀(*Naja naja* Cantor, *Bungarus fasciatus* Schneider) 또는 Colubridae 과에 속하는 뱀(*Elaphe radiata* Schlegel, *Ptyas korros* Schlegel, *Zaocys dhumnades* Cantor)의 쓸개를 말린것이다. 저담(猪膽, Suis Fellis Pulvis)은 Suidae 과에 속하는 돼지(*Sus scrofa* Linne, *Sus scrofa domestica* Brisson)의 담즙을 말린 것이다. 다음은 우담, 웅담, 사담, 저담의 약재에 대한 구성 성분의 리스트이다.

- 우담: CA, DCA, CDCA, UDCA, TCA, GCA, GDCA, GCDCA, glycohyodeoxycholic acid (GHDCA), TDCA, TLCA, TCDCA, taurohyodeoxycholic acid (THDCA), tauroursodeoxycholic acid (TUDCA) [62, 63, 72, 73].
- 웅담: CA, CDCA, UDCA, LCA, TCA, GDCA, GLCA, GCDCA, TDCA, TLCA, TCDCA, 7-keto-TCDCA, TUDCA [62, 66, 73].
- 저담: CA, DCA, CDCA, HDCA, UDCA, GCA, GDCA, glycohyocholic acid (GHCA), GCDCA, GHDCA, GLCA, TCA, taurohyocholic acid (THCA), TLCA, TCDCA, THDCA [61-63, 72, 74, 75].
- 사담: TCA, LCA, GDCA, TDCA, TCDCA [62]

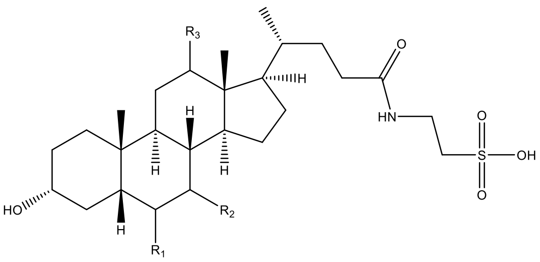
Figure 15-16 은 위에서 언급한 bile acid, taurine, bilirubin 의 화학 구조이다. Bile acid 는 스테로이드의 한 종류로써 C-17 위치에 있는 side chain 에 카르복실 그룹을 가지는 특징이 있다.



| Compound | $R_1$ | $R_2$ | $R_3$ | PubChem | Ref. |
|---|---|---|---|---|---|
| **(234)** CA | H | α-OH | α-OH | 221493 | [60-72] |
| **(235)** DCA | H | H | α-OH | 222528 | [60-63, 65, 66, 68-72] |
| **(236)** CDCA | H | α-OH | H | 10133 | [60-63, 65-67, 69-71] |
| **(237)** HDCA | α-OH | H | H | 5283820 | [60-63, 67-72] |
| **(238)** UDCA | H | β-OH | H | 31401 | [60-63, 65, 66, 68-70] |
| **(239)** LCA | H | H | H | 9903 | [62, 64, 66, 69] |
| **(240)** 3α,12α-dihydroxy-7-oxo-5β-cholanic acid | H | =O | α-OH | | [64] |

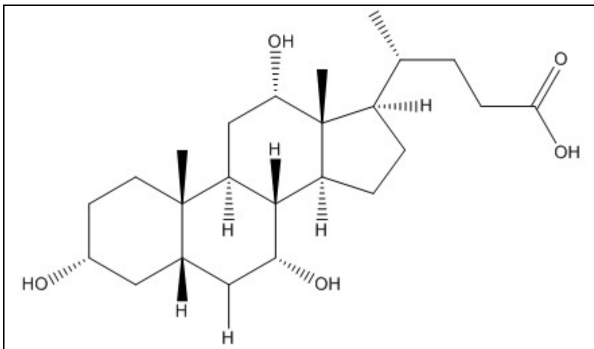


| Compound | $R_1$ | $R_2$ | $R_3$ | PubChem | Ref. |
|---|---|---|---|---|---|
| **(241)** GCA | H | α-OH | α-OH | 10140 | [62, 64, 66, 69, 73] |
| **(242)** GDCA | H | H | α-OH | 3035026 | [62, 64, 66, 73] |
| **(243)** GCDCA | H | α-OH | H | 12544 | [62, 66, 69, 75] |
| **(244)** GHCA | α-OH | α-OH | H | 71361462 | [75] |
| **(245)** GHDCA | α-OH | H | H | 114611 | [62, 75] |
| **(246)** GLCA | H | H | H | 115245 | [62, 66] |

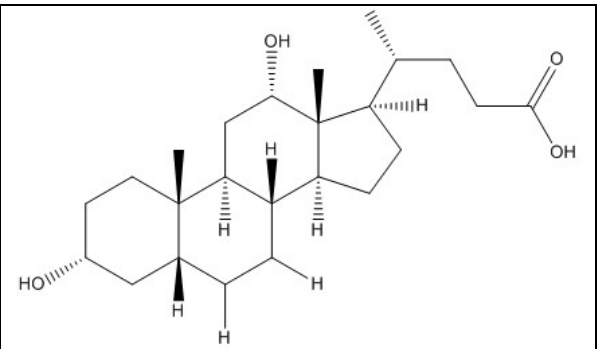


| Compound | $R_1$ | $R_2$ | $R_3$ | PubChem | Ref. |
|---|---|---|---|---|---|
| **(247)** TCA | H | α-OH | α-OH | 6675 | [61-66, 68-70, 73] |
| **(248)** TDCA | H | H | α-OH | 2733768 | [62, 66, 69, 73] |
| **(249)** TCDCA | H | α-OH | H | 387316 | [62, 66, 73, 74] |
| **(250)** THCA | α-OH | α-OH | H | 11954195 | [74] |
| **(251)** THDCA | α-OH | H | H | 119046 | [62, 74] |
| **(252)** TLCA | H | H | H | 439763 | [62, 66, 69] |
| **(253)** TUDCA | H | β-OH | H | 9848818 | [62, 66, 73] |
| **(254)** 7-keto-TCDCA | H | =O | H | | [66] |

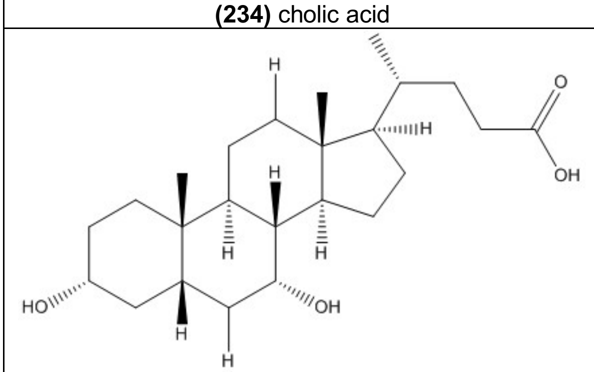
Figure 15. Chemical structures of bile acids.



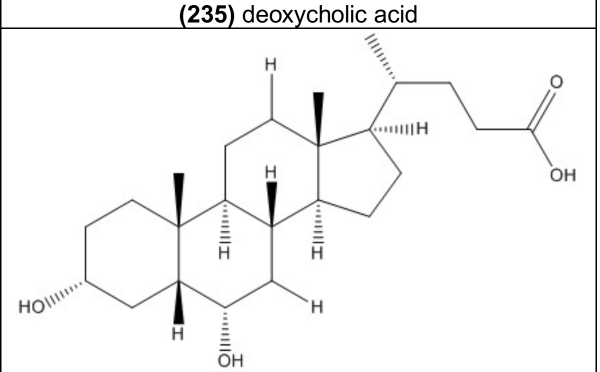
**(234)** cholic acid



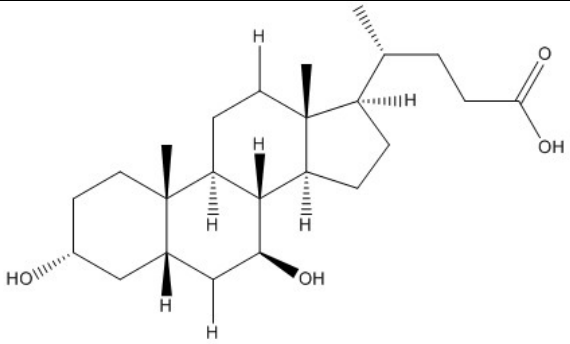
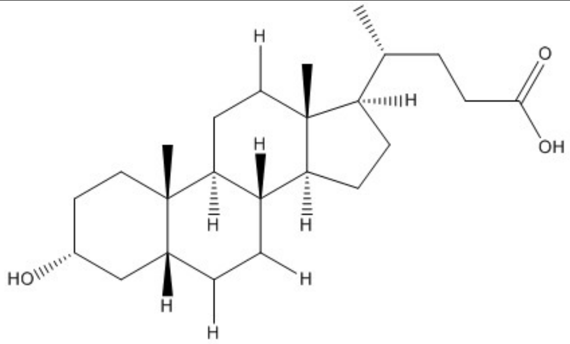
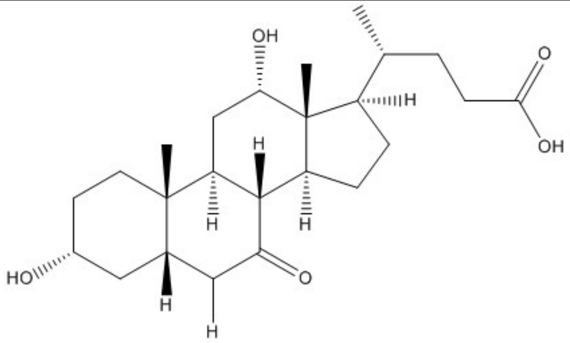
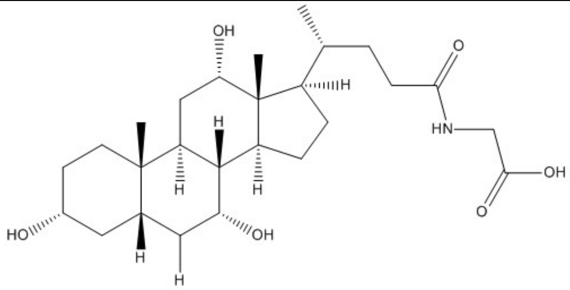
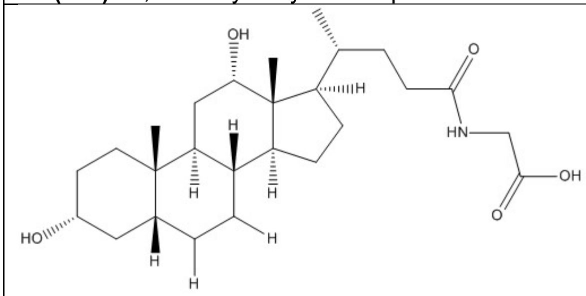
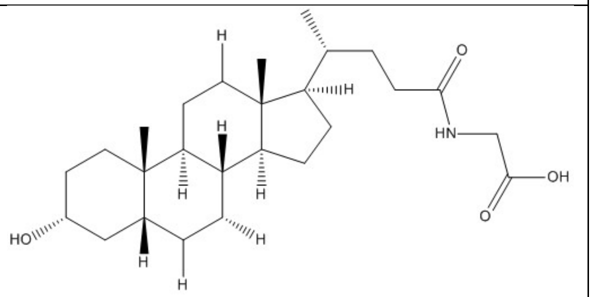
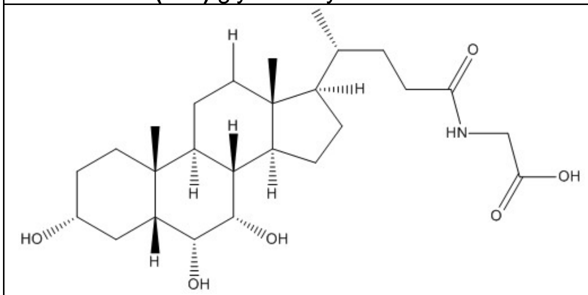
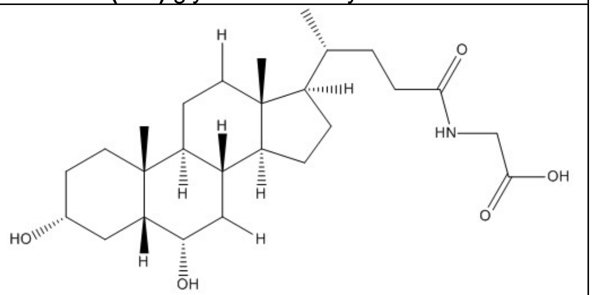
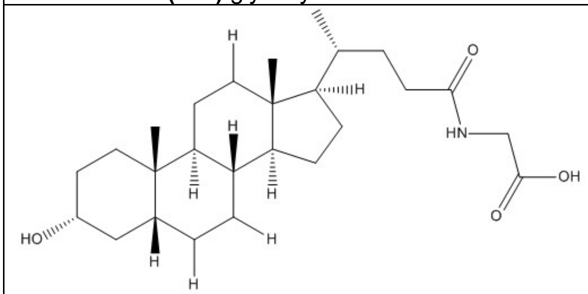
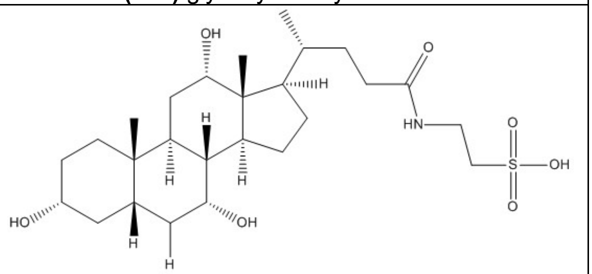
**(235)** deoxycholic acid

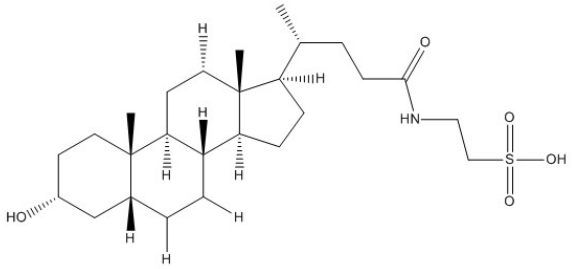
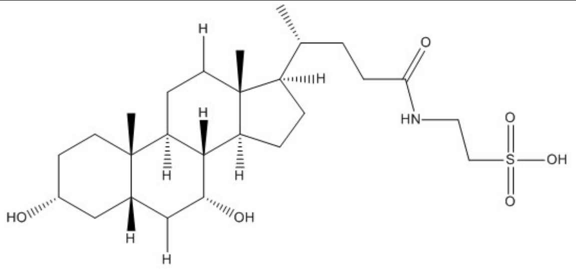
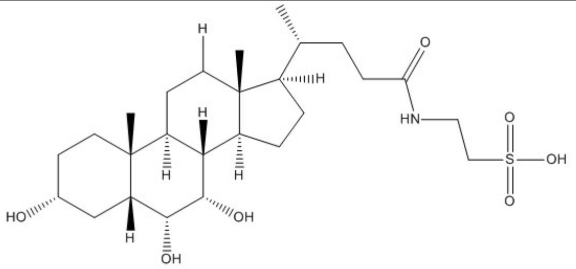
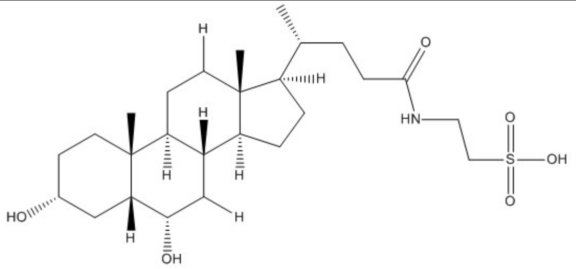
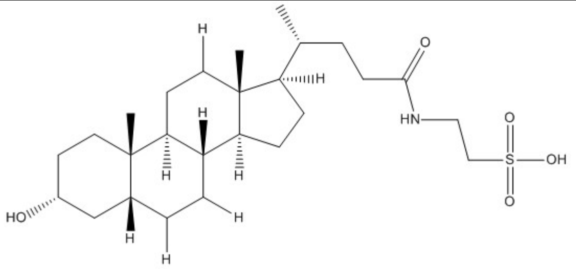
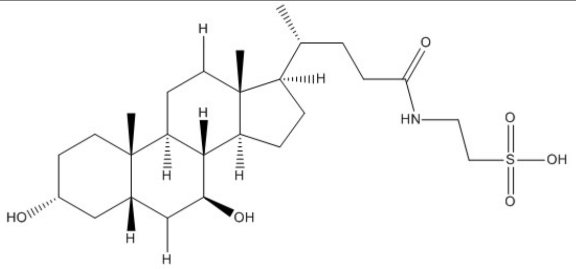
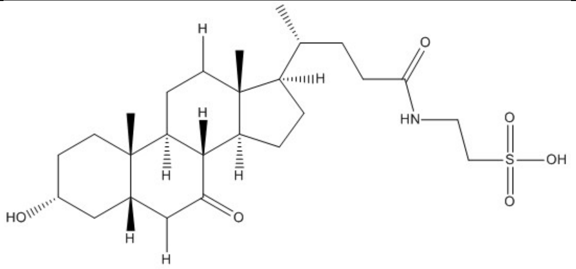


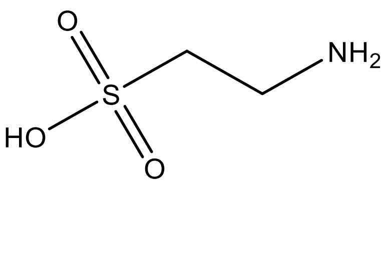
**(236)** chenodeoxycholic acid



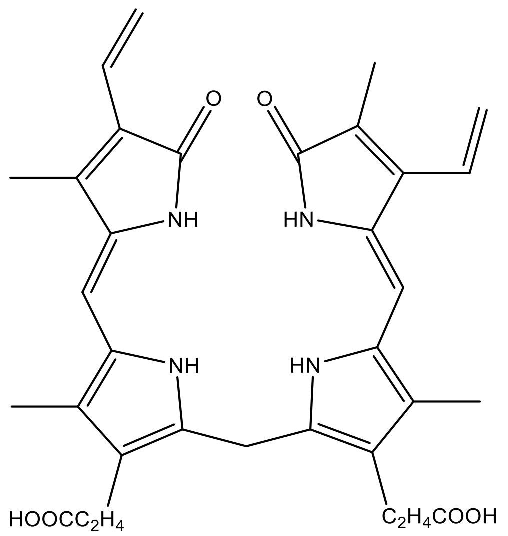
**(237)** hyodeoxycholic acid

| | |
|---|---|
| <br>**(238)** ursodeoxycholic acid | <br>**(239)** lithocholic acid |
| <br>**(240)** 3α,12α-dihydroxy-7-oxo-5β-cholanic acid | <br>**(241)** glycocholic acid |
| <br>**(242)** glycodeoxycholic acid | <br>**(243)** glycochenodeoxycholic acid |
| <br>**(244)** glycohyocholic acid | <br>**(245)** glycohyodeoxycholic acid |
| <br>**(246)** glycolithocholic acid | <br>**(247)** taurocholic acid |

| | |
|---|---|
| <br>**(248)** taurodeoxycholic acid | <br>**(249)** taurochenodeoxycholic acid |
| <br>**(250)** taurohyocholic acid | <br>**(251)** taurohyodeoxycholic acid |
| <br>**(252)** taurolithocholic acid | <br>**(253)** tauroursodeoxycholic acid |
| <br>**(254)** 7-keto-taurochenodeoxycholic acid | |



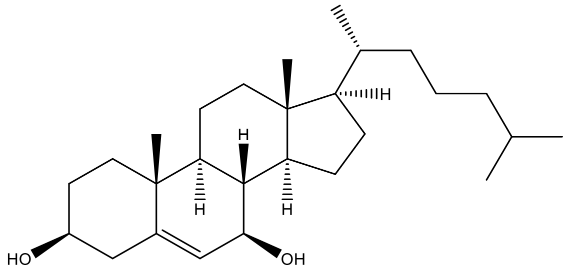
**(255)** taurine (PubChem 1123) [69]



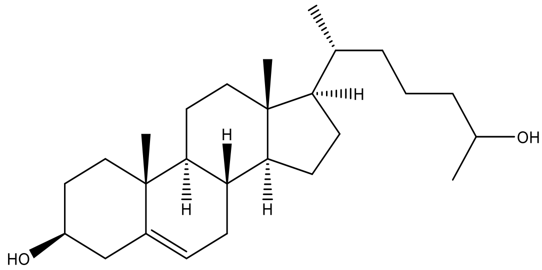
**(256)** bilirubin (PubChem 5280352) [60, 69]

Figure 16. Chemical structures of taurine and bilirubin in animal bile.

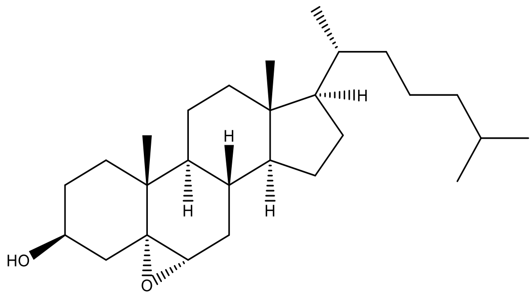
동물의 담즙은 여러 sterol 들을 포함하고 있다. Figure 17 은 우황과 인공우황에서 추출된 5 개의 oxysterol 에 대한 화학 구조이다 [76].



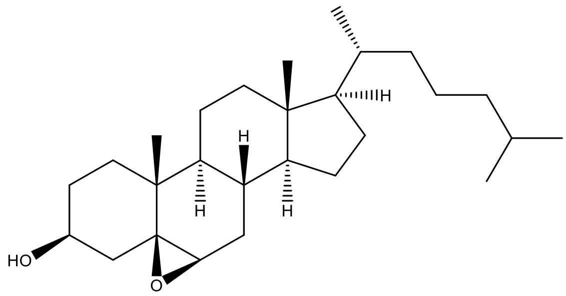

**(257)** 7β-hydroxycholesterol (PubChem 473141)



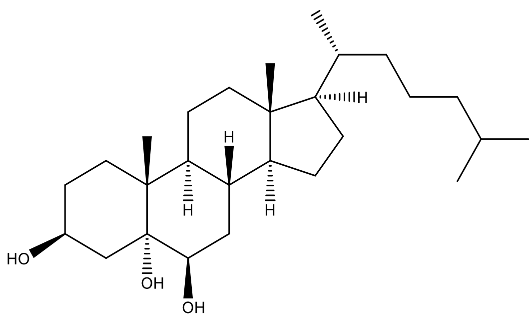

**(258)** 25-hydroxycholesterol (PubChem 65094)




**(259)** 5,6α-epoxycholesterol (PubChem 288202)




**(260)** 5,6β-epoxycholesterol (PubChem 288202)



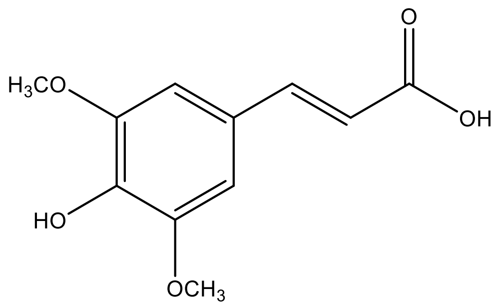

**(261)** cholestane-3β,5α,6β-triol (PubChem 91498)

Figure 17. Chemical structures of oxysterols identified from Bovis Calculus and Artificial Calculus Bovis.

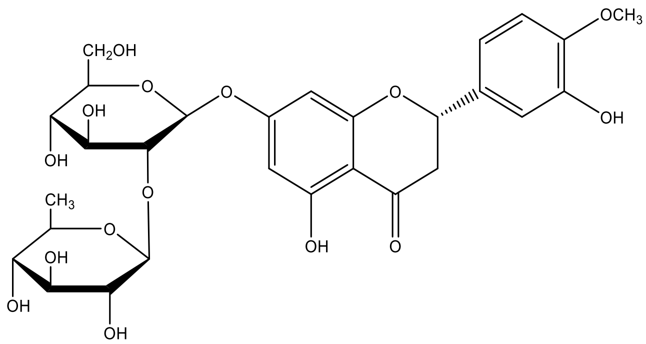
Bile acid 이외에도 우담과 웅담에는 **(262)** phosphatidylcholine, **(263)** phosphatidylethanolamine, **(264)** phosphatidylinositol 와 같은 phospholipid 들도 발견되었다 [73, 77].

### 3.6. 담남성(膽南星), Arisaema cum Bile

담남성(膽南星, Arisaema cum Bile)은 Araceae 과에 속하는 천남성(*Arisaema amurense* Maximowicz, *Arisaema erubescens* Schott, *Arisaema heterophyllum* Blume) 가루와 소나나 양 또는 돼지의 담즙을 섞어 발효 가공한 약재이다. 담남성은 전통의학 치료에서 많이 사용되었으며, 고문헌에는 그 효능이 알려져 있으나, 현재 의학에서는 담낭성에 대한 성분 분석과 같은 약리학적 연구가 거의 없는 상황이다. PubMed 에는 담당성에서 **(119)** gallic acid, **(174)** chlorogenic acid, **(173)** syringic acid, **(109)** ferulic acid, **(265)** sinapic acid, **(156)** catechin, **(132)** quercetin, **(266)** neohesperidin 의 8 개 phenolic 을 추출한 연구 하나만 존재한다 [78]. 이 phenolic 중에서 sinapic acid 와 neohesperidin 의 구조는 다음과 같다.




**(265)** sinapic acid (PubChem 637775)

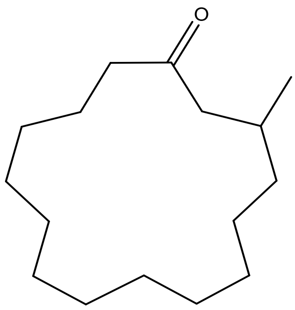



**(266)** neohesperidin (PubChem 442439)

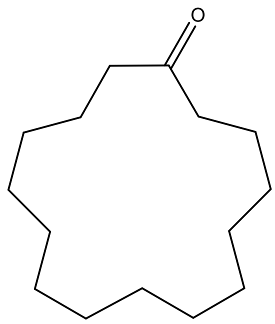
Figure 18. Chemical structures of sinapic acid and neohesperidin identified from Arisaema cum Bile.

### 3.7. 사향(麝香, Moschus)

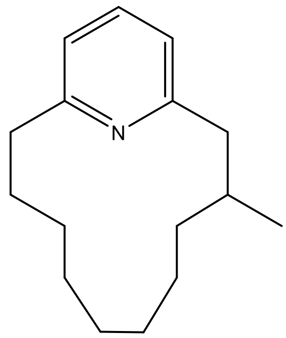
사향(麝香, Moschus, Musk)은 Moschidae 과에 속하는 사향쥐(*Moschus berezovskii* Flerove, *M. chrysogaster* Hodgson, *M. moschiferus* Linne, *M. sifanicus* Przewalski) 수컷의 사향선 분비물이다. 사향은 전세계적으로 향수 제조에 이용되는 중요한 재료일 뿐만 아니라, 전통의학 분야에서 가장 유명하고 비싼 약재 중에 하나이다. 사향의 성분에 대해서는 많은 연구가 수행되어 왔으며, 사향은 **(267)** muscone, steroid, lipid, protein 등을 포함한다고 알려져 있다 [79-83]. 특히, muscone 은 사향의 독특한 향기를 내는 성분으로써 사향의 품질을 평가하는데 가장 중요하게 이용된다. 또한 muscone 과 비슷한 구조를 가지는 성분으로 **(268)** normuscone 과 **(269)** muscopyridine 이 사향에서 추출되었다.




**(267)** muscone
(=3-methylcyclopentadecanone)
(PubChem 10947) [79, 80, 82, 83]



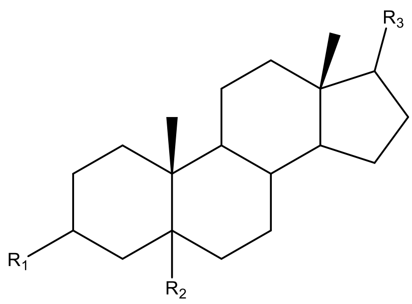

**(268)** normuscone
(PubChem 10409) [83]



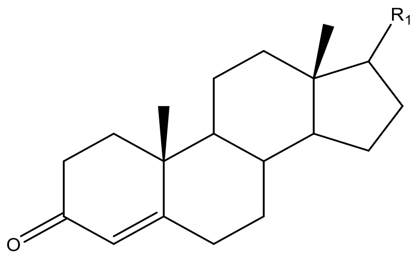

**(269)** muscopyridine
(PubChem 193306) [79]

Figure 19. Chemical structures of muscone, normuscone, and muscopyridine as identified from Moschus.

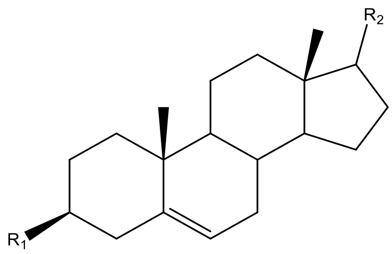
Steroid 는 사향의 구성성분에서 큰 비중을 차지한다. 사향에서 검출된 주요 steroid 는 아래 그림에 나오는 것과 같다. 이 외에 섬수의 구성 성분 중 하나인 **(1)** resibufogenin [83] 도 사향에서 추출되었다.



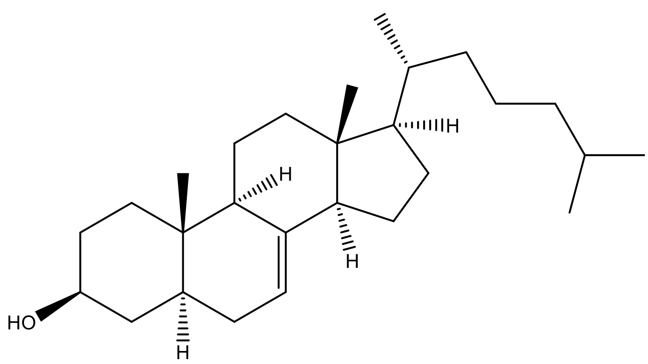

| Compound | $R_1$ | $R_2$ | $R_3$ | PubChem | Ref. |
|---|---|---|---|---|---|
| **(270)** androsterone | α-OH | α-H | =O | 5879 | [81] |
| **(271)** etiocholanolone | α-OH | β-H | =O | 5880 | [81] |
| **(272)** 5α-androstane-3α,17β-diol | α-OH | α-H | β-OH | 15818 | [81] |
| **(273)** 5β-androstane-3α,17β-diol | α-OH | β-H | β-OH | 134494 | [81] |
| **(274)** epiandrosterone | β-OH | α-H | =O | 441302 | [81] |
| **(275)** 3α-hydroxy-5β-androstan-17-one | α-OH | β-H | =O | 5880 | [83] |
| **(276)** androsterone, trifluoroacetate | α-OH | α-H | =O | 543348 | [83] |
| **(277)** dehydroandrosterone | α-OH | α-H | β-OH | 15818 | [83] |
| **(278)** 3-ethyl-3-hydroxy-5α-androstan-17-one | 3-ethyl-3-hydroxy | α-H | =O | 14681481 | [83] |
| **(279)** cholestan-3-ol | OH | H | 1α-methyl-5-methylhexane-1-yl | 10992748 | [83] |



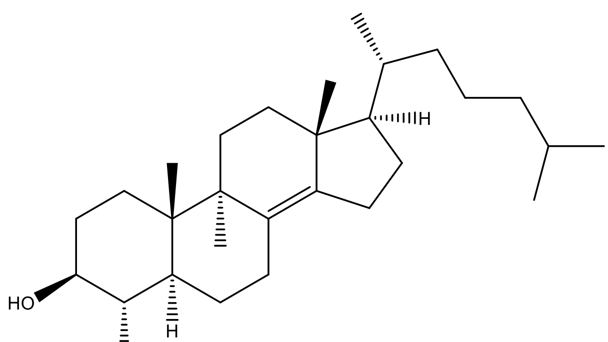

| Compound | $R_1$ | PubChem | Ref. |
|---|---|---|---|
| **(280)** testosterone | β-OH | 6013 | [81] |
| **(281)** epitestosterone | α-OH | 10204 | [81] |
| **(282)** androst-4-ene-3,17-dione | =O | | [81] |




| Compound | $R_1$ | $R_2$ | PubChem | Ref. |
|---|---|---|---|---|
| **(283)** cholesterol | OH | 6-methylheptan-2-yl | 5997 | [81, 83] |
| **(284)** dehydroepiandrosterone | OH | =O | 5881 | [81] |
| **(285)** prasterone-3-sulfate | $OSO_3H$ | =O | 12594 | [83] |

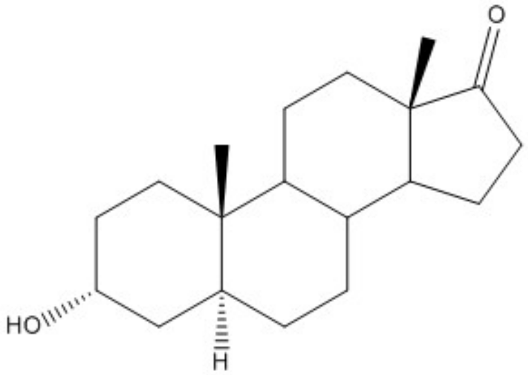



**(286)** cholest-7-en-3β-ol
(PubChem 9930097) [83]

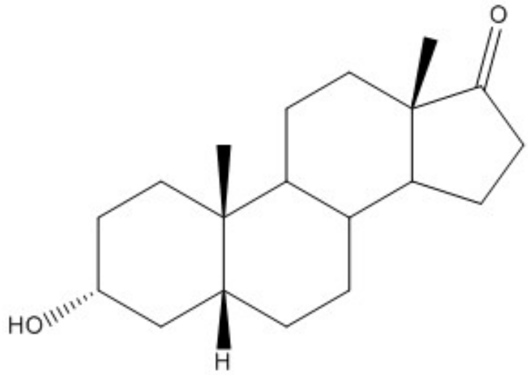



**(287)** 4α-methyl-5α-cholest-8(14)-en-3β-ol
(PubChem 23621393) [83]

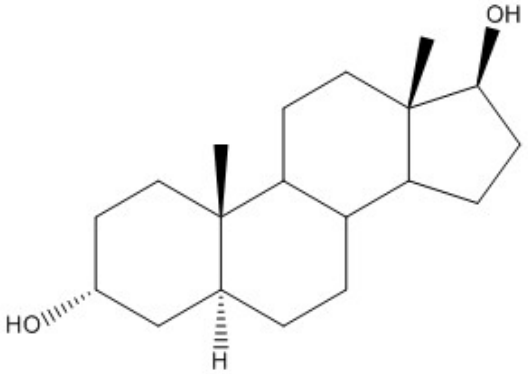
Figure 20. Chemical structures of steroids identified from Moschus.



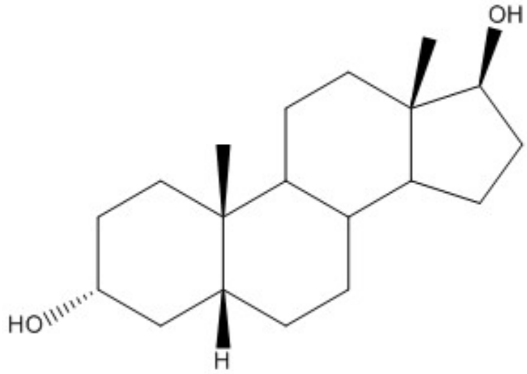
**(270)** androsterone



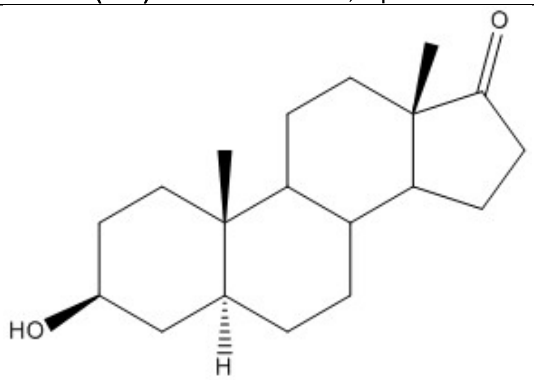
**(271)** etiocholanolone



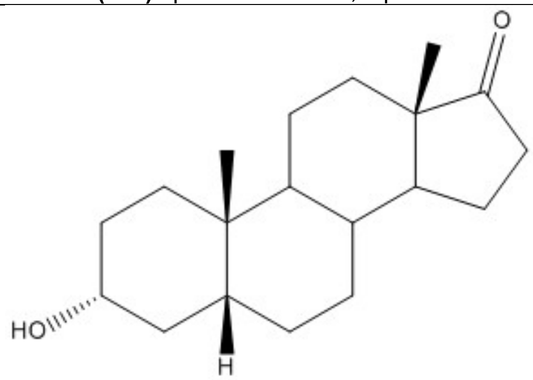
**(272)** 5α-androstane-3α,17β-diol



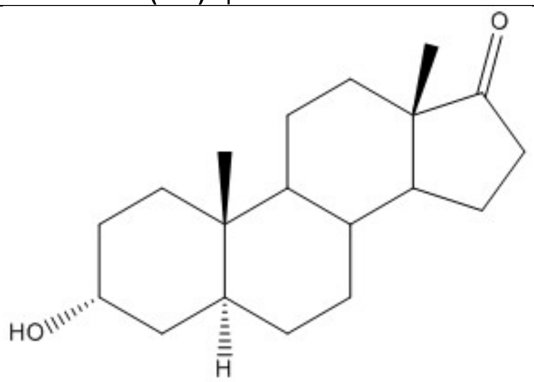
**(273)** 5β-androstane-3α,17β-diol



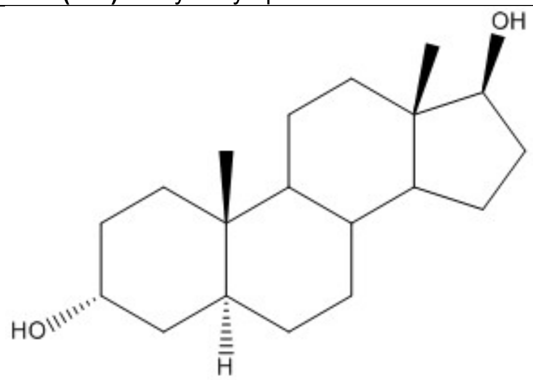
**(274)** epiandrosterone



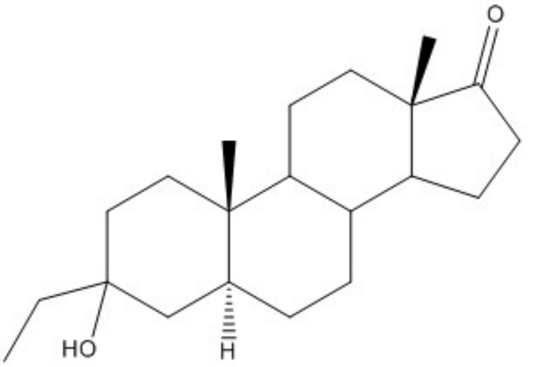
**(275)** 3α-hydroxy-5β-androstan-17-one



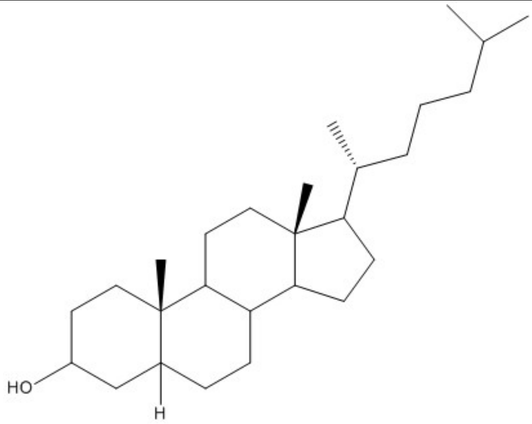
**(276)** androsterone, trifluoroacetate



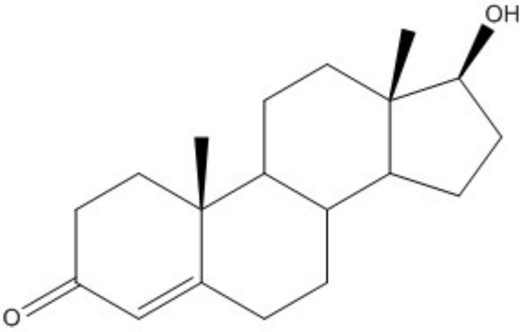
**(277)** dehydroandrosterone



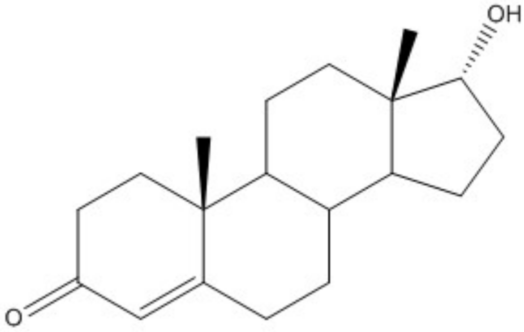

**(278)** 3-ethyl-3-hydroxy-5α-androstan-17-one



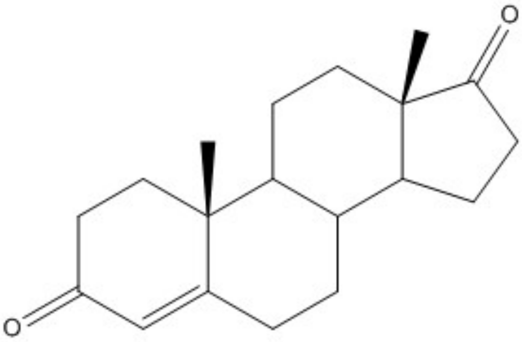

**(279)** cholestan-3-ol



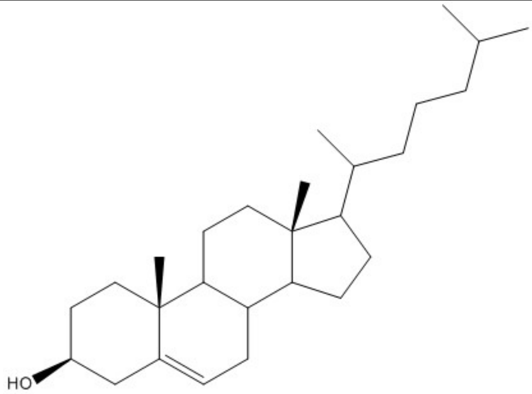

**(280)** testosterone



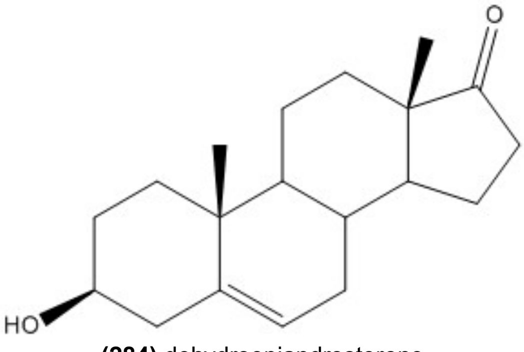

**(281)** epitestosterone



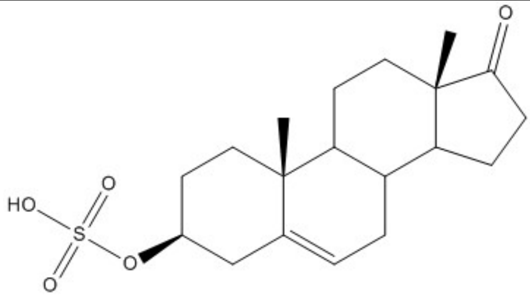

**(282)** androst-4-ene-3,17-dione




**(283)** cholesterol

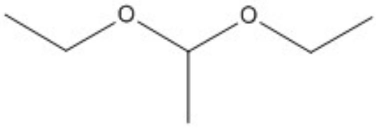



**(284)** dehydroepiandrosterone

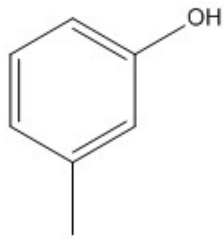



**(285)** dehydroepiandrosterone

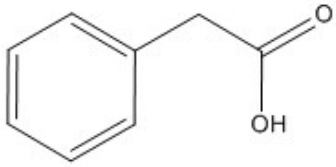
Steroid 이외에 Li et al.[83] 의 연구에서는 아래 그림과 같은 alkane, alcohol, aldehyde, aliphatic ester 들을 사향에서 추출하였다.



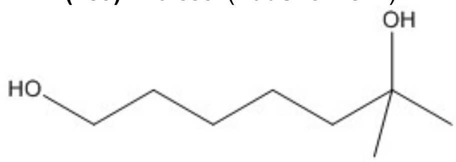
**(288)** 1,1-diethoxy-ethane (acetal)
(PubChem 7765)



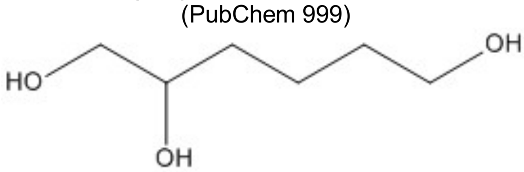
**(289)** m-cresol (PubChem 342)



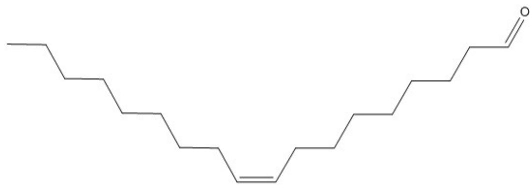
**(290)** benzeneacetic acid
(PubChem 999)



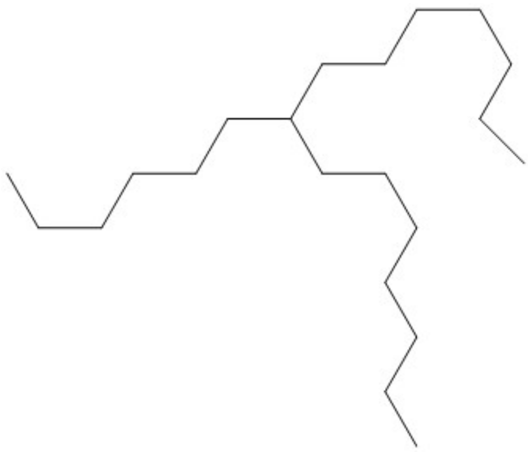
**(291)** 6-methylheptane-1,6-diol



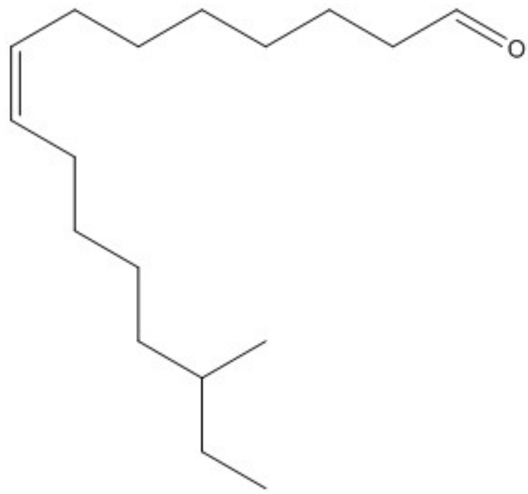
**(292)** 1,2,6-hexanetriol
(PubChem 7823)



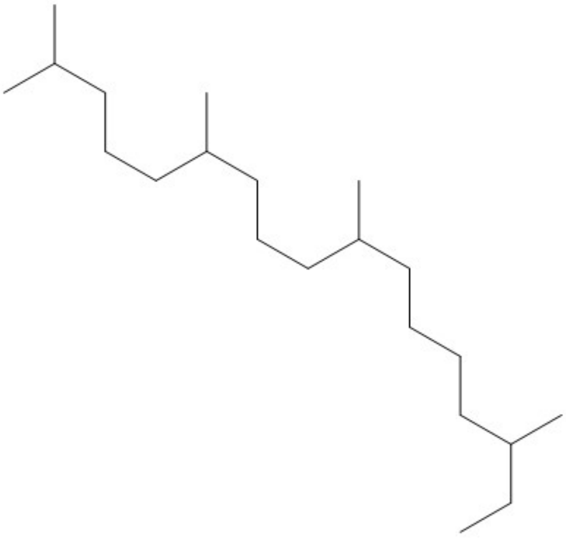
**(293)** olealdehyde
(PubChem 5364492)



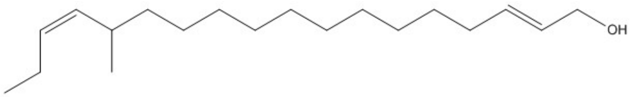
**(294)** 8-n-hexylpentadecane
(PubChem 300518)



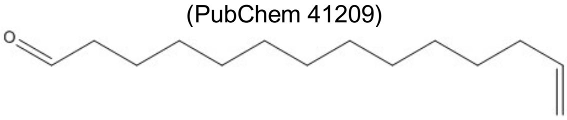
**(295)** 14-methyl-8-hexadecenal Z
(PubChem 5364688)



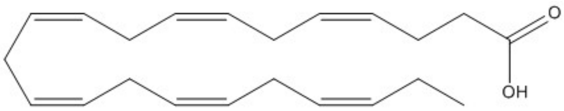
**(296)** 2,6,10,15-tetramethylheptadecane
(PubChem 41209)



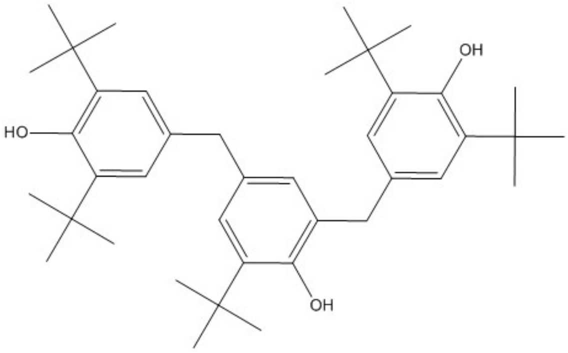

**(297)** 12-methyl-E,E-2,13-octadecadien-1-ol




**(298)** 13-tetradecenal
(PubChem 522841)




**(299)** doconexent
(PubChem 445580)




**(300)** 2-tert-butyl-4,6-bis(3,5-di-tert-butyl-4-hydroxybenzyl)phenol

Figure 21. Chemical structures of alkane, alcohols, aldehydes, aliphatic esters identified from Moschus.

## 3.8. 녹용(鹿茸), Cervi Cornu Pantotrichum

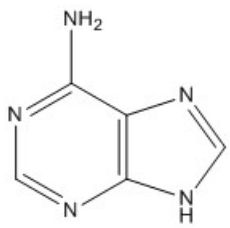
녹용(鹿茸, Deer antler)은 Cervidae 과에 속하는 사슴(*Cervus nippon* Temminck, *C. elaphus* Linne, *C. canadensis* Erxleben)의 골질화되지 않은 뿔을 말린 것이다. 녹용의 성분은 phospholipid, ganglioside, glycoprotein, nucleoside, amino acid, protein, cholesterol 등인 것으로 알려져 있다 [84-90].

Kim et al.[84] 은 녹용에서 C14:0, C16:0, C18:0, C18:1, C18:2, C20:4 타입의 fatty acid 를 가지는 **(262)** phosphatidylcholine 들을 추출하였으며, Jhon et al. [85] 은 녹용에서 아래 표와 같은 5 가지 **(213)** ganglioside 들이 존재하는 것을 확인하였다.

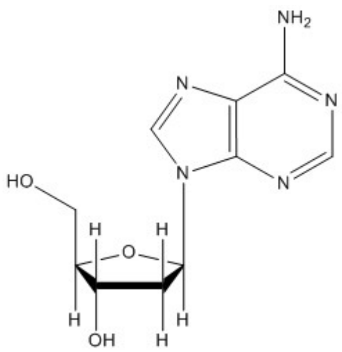
Table 4. Gangliosides identified from CCP.

| Ganglioside | Sphingoid base | Fatty acid | Sialic acid |
|---|---|---|---|
| $GM_3$ | eicosasphingosine (C20) | C22:0 | Neu5Ac |
| $GM_3$ | sphingosine (C18) | C16:0 | Neu5Ac |
| $GM_3$ | sphingosine (C18) | C16:0 | Neu5Gc |
| $GD_3$ | eicosasphingosine (C20) | C22:0 | Neu5Ac |
| $GD_3$ | sphingosine (C18) | C16:0 | Neu5Ac |

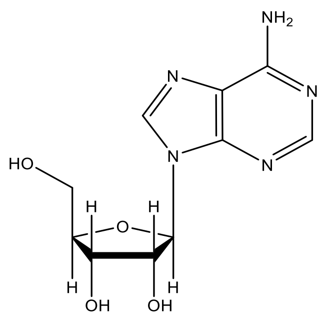
Glycosaminoglycan 은 disaccharide 들이 반복적으로 연결되어 만들어진다. 녹용의 glycosaminoglycan 은 **(301)** chondroitin 4-sulfate [86], **(302)** chondroitin 6-sulfate [86], **(303)** dermatan sulfate [86], **(304)** heparan sulfate [87] 들을 포함하는 것으로 알려져 있다. 이 외에도 녹용에서 아래 그림과 같은 17 개의 nucleoside 와 nucleobase 들을 추출한 연구들도 존재하였다.



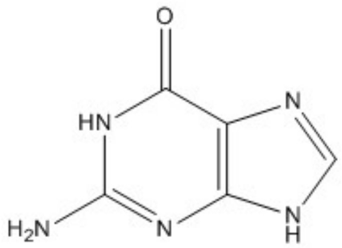
**(305)** adenine [88]



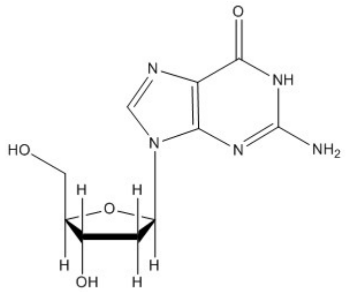
**(306)** 2'-deoxyadenosine [88]



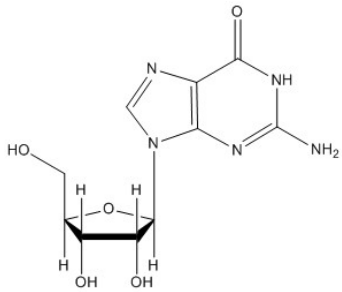
**(232)** adenosine [88-90]



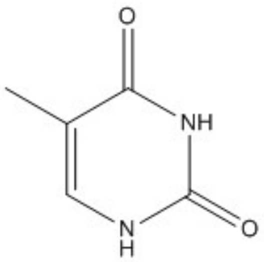
**(307)** guanine [88-90]



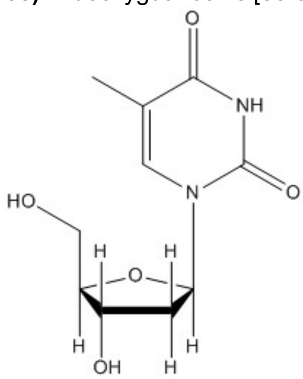
**(308)** 2'-deoxyguanosine [88-90]



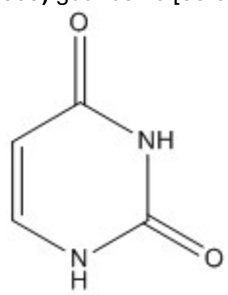
**(309)** guanosine [88-90]



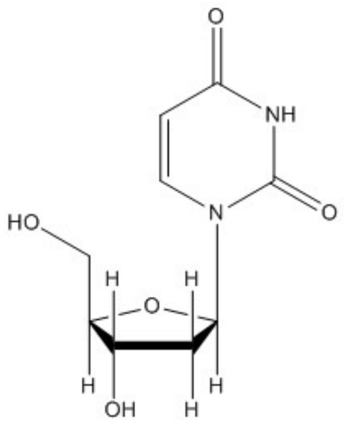
**(310)** thymine [88, 89]



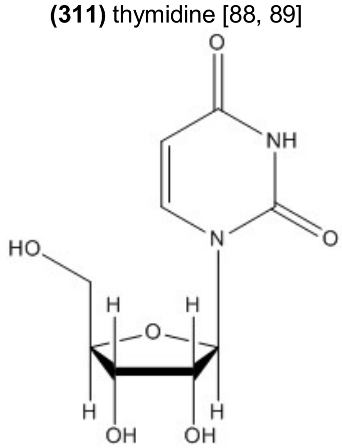
**(311)** thymidine [88, 89]



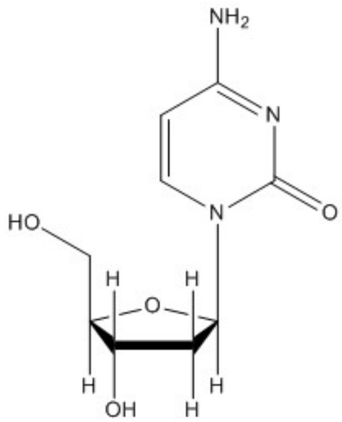
**(312)** uracil [88-90]



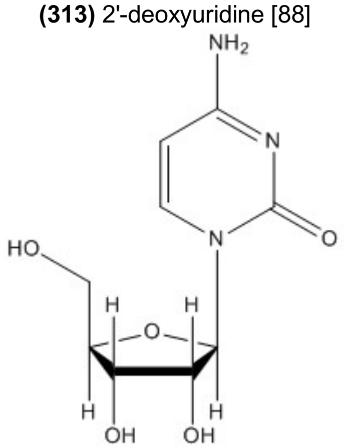
**(313)** 2'-deoxyuridine [88]



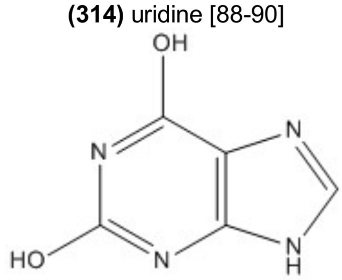
**(314)** uridine [88-90]



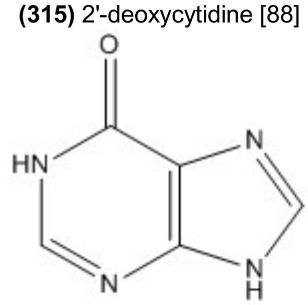
**(315)** 2'-deoxycytidine [88]



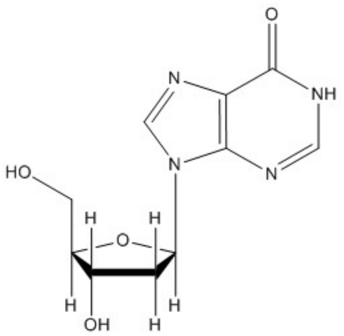
**(316)** cytidine [88, 89]



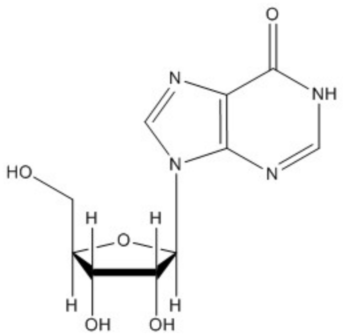
**(317)** xanthine [88]



**(318)** hypoxanthine [88-90]



**(319)** 2'-deoxyinosine [88]



**(320)** inosine [88-90]

Figure 22. Chemical structures of nucleosides and nucleobases identified from CCP.

### 3.9. 수우각(水牛角), Bubali Cornu

수우각(水牛角, Bubali Cornu, water buffalo horn)은 Bovidae 과에 속하는 *Bubalus bubalis* Linnaeus 의 뿔이다. 수우각의 구성 성분은 amino acid, peptide, cholesterol 들을 포함하는 것으로 알려져 있다. 최근 Liu et al [91]은 수우각으로부터 **(321)** WBH-1, **(322)** WBH-2, **(323)** WBH-3 와 같이 세 종류의 peptide 들을 추출하였다. WBH-1, WBH-2, WBH-3 의 아미노산 시퀀스는 각각 Gln-Tyr-Asp-Gln-Gly-Val (708 Da), Tyr-Glu-Asp-Cys-Thr-Asp-Cys-Gly-Asn (1018 Da), Ala-Ala-Asp-Asn-Ala-Asn-Glu-Leu-Phe-Pro-Pro-Asn (1271 Da)이다.

### 3.10. 수질(水蛭), Hirudo

수질(水蛭, Hirudo)은 거머리(Hirudinidae 과에 속하는 *Hirudo nipponica* Whitman, Haemopidae 과에 속하는 *Whitmania pigra* Whitman 나 *W. acranulata* Whitman)의 몸체를 말린 것이다. 수질에 포함된 성분은 nucleobase, amino acid, peptide 들로 알려져 있는데, 특히 수질의 anticoagulant peptide 들에 대해서 많은 약리학적 연구가 수행되어 왔다. Thrombin inhibitor 로 작용하는 대표적인 anticoagulant 인 hirudin 은 *Hirudo medicinalis* 에서 추출된 성분인데 오래 전부터 임상에서 많이 사용되어 왔다 [92, 93]. 이러한 hirudin 과 유사한 anticoagulant peptide 들로써, 최근 **(324)** whitmanin(8608 Da) [92], **(325)** whitide(1997.1 Da) [94], **(326)** WP-30(3140.63 Da) [95], **(327)** H1(14998 Da), **(328)** H2(15988 Da), **(329)** H3(15956 Da) [96], **(330)** WA3-1(1422 Da) [97] 등이 수질에서 추출되었다. 이 peptide 들 중에서 whitide, WP-30, WA3-1 의 아미노산 시퀀스는 GPAGPVGAPGGPGVRGLPGDRG, VISRTQSNVQAAWGQVGGHA ADYSAVAIER, HDFLNNKLEYE 로 알려져 있다. 또한, **(331)** HF2 (<874 Da)라는 high Fischer's ratio peptide 도 수질에서 추출되었다 [97]. Peptide 이외에도 **(181)** Gly, **(184)** Ala, **(186)** Val, **(191)** Leu, **(190)** Ile, **(187)** Met, **(188)** Trp, **(189)** Phe, **(178)** Ser, **(182)** Thr, **(185)** Tyr, **(192)** Lys, **(183)** Arg, **(180)** His 의 14 개 amino acid [98] 와 **(312)** uracil, **(317)** xanthine [98], **(318)** hypoxanthine [93, 99] 의 nucleobase 도 수질에서 추출되었다.

### 3.11. 영와(鈴蛙), Bombina

영와(鈴蛙, Bombina)는 Bombinatoridae 과에 속하는 무당개구리(*Bombina orientalis* Bouglenger)의 몸체를 말린 것이다. 영와의 성분에 대한 연구들은 주로 영와의 피부에서 추출한 peptide 에 대해서 이루어졌다. **(332)** Bombesin (PubChem 16133800)은 영와에서 추출된 14-amino acid peptide (1619.9 Da)이다 [100]. Bombesin 의 아미노산 시퀀스는 Pyr-Gln-Arg-Leu-Gly-Asn-Gln-Trp-Ala-Val-Gly-His-Leu-Met 이며, N-terminal 에 pyroglutamic acid 가 있고 C-terminal 에 $NH_2$ 가 존재한다. 최근에는 **(333)** DV-28 (3198.5 Da)라는 peptide 가 영와의 피부 분비물에서 발견되었는데, 이 peptide 의 아미노산 시퀀스는. DMYEIKGFKSAHGRPRVCPPGEQCPIWV 이며, Cys18 과 Cys24 사이에 disulfide bridge 가 있고 amidated C-terminal Val residue 를 가진다 [101].

### 3.12. 오공(蜈蚣), Scolopendra

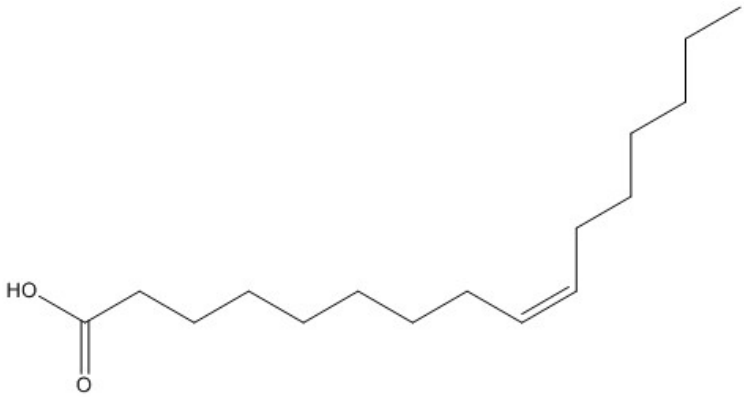
오공(蜈蚣, Scolopendra)은 Scolopendridae 과에 속하는 지네(*Scolopendra subspinipes mutilans* L. Koch)의 몸체를 말린 것이다. 오공에서는 antithrombotic activity 를 가지는 **(334)** Ser-Gln-Leu 의 peptide 가 발견되었으며[102], **(176)** Asp, **(183)** Arg, **(184)** Ala, **(191)** Leu, **(192)** Lys 의 5 개 아미노산이 추출되었다 [103].

### 3.13. 자충(蟅蟲), Eupolyphaga

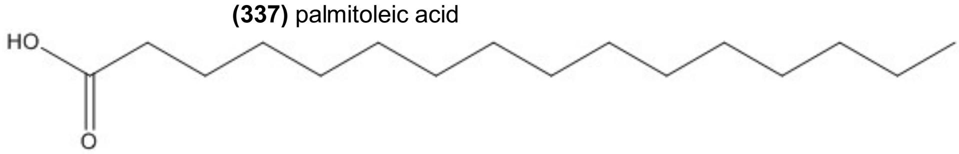
자충(蟅蟲, Eupolyphaga)은 Corydiidae 과에 속하는 암컷바퀴(*Eupolyphaga sinensis* Walker, *Steleophaga plancyi* (Boleny))의 몸체를 말린 것으로, Steleophaga 또는 Cockroach 로도 알려져 있다. 자충에서는 antimicrobial peptide 인 **(335)** Es-termicin 이 추출되었다 [104]. Es-termicin 의 아미노산 시퀀스는 ACDFQQCWVTCQRQYSINFISARCNGDSCVCTFRT 인데, filamentous fungi 를 억제하는 것으로 알려진 termicin 의 시퀀스와 매우 유사하다.

## 3.14. 맹충(虻蟲), Tabanus

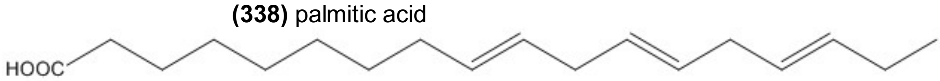
맹충(虻蟲, Tabanus)은 Tabanidae 과에 속하는 *Tabanus mandarinus* Schiner, *T. bivittatus* Matsumura 의 암컷 성충의 몸체를 말린 것이다. 맹충에서는 anticoagulant activity 를 가지는 **(336)** tabanus anticoagulant protein (65k Da)이 추출되었다[105]. 또한 Ding et al.[106]의 연구에서는 맹충에서 21 가지의 fatty acid 들을 추출하였는데, 이 중에서 **(337)** palmitoleic acid, **(338)** palmitic acid, **(339)** linoleic acid, **(340)** oleic acid, **(341)** stearic acid 가 주요 성분이라는 것을 보였다.



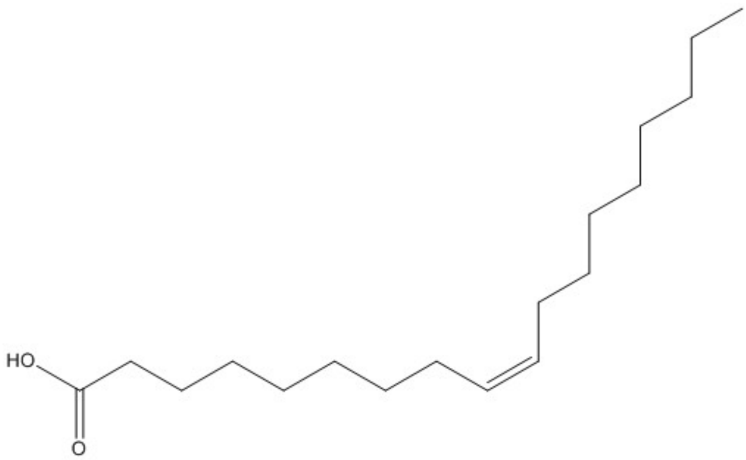

**(337)** palmitoleic acid



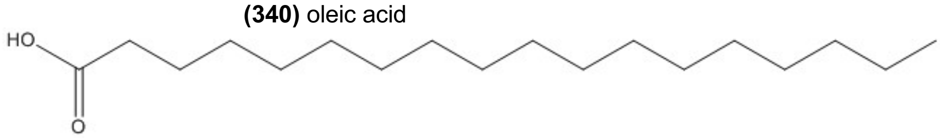

**(338)** palmitic acid




**(339)** linoleic acid




**(340)** oleic acid




**(341)** stearic acid

### 3.15. 반묘(斑猫), Mylabris

반묘(斑猫, Mylabris)는 Meloidae 과에 속하는 *Mylabris cichorii* Linne, *M. phalerata* Pallas, *Epicauta gorhami* Marseul 의 몸체를 말린 것이다. 한국 약전과 중국 약전에서는 반묘의 지표 성분은 **(342)** cantharidin (PubChem 5944)라고 언급하고 있다. PubMed 에서는 biotransformation 이전과 이후에 반묘의 cantharidin 함량을 비교하는 연구가 존재하였다 [107].

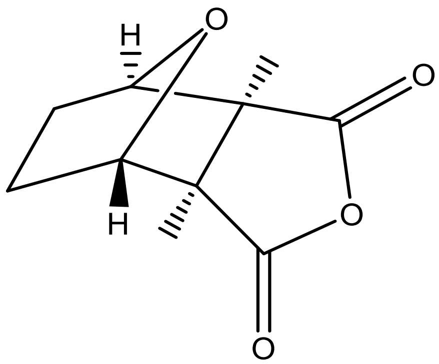
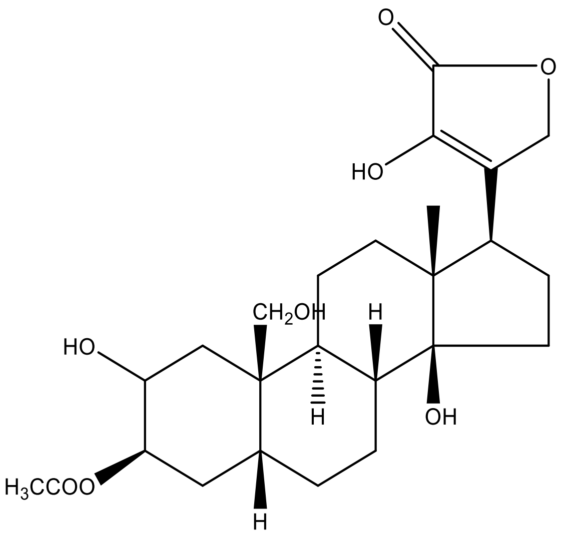


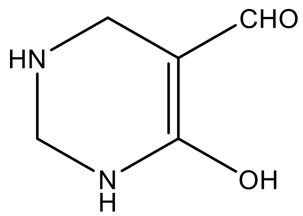

Figure 23. Chemical structures of cantharidin identified from Mylabris.

## 3.16. 전갈(全蝎), Scorpio

전갈(全蝎, Scorpio)은 Buthidae 과의 전갈(*Buthus martensii* Karsch) 몸체를 말린 것이다. 전갈 약재의 주요 성분은 전갈이 만든 독에 집중되어 있다고 알려져 있으며, 전갈 독은 analgesic peptide 또는 antitumor peptide 들을 포함하고 있다. 현재까지 전갈에서 추출된 대표적인 analgesic peptide 들은 **(343)** BmK I1, **(344)** BmK I4, **(345)** BmK I6, **(346)** BmK AngP1, **(347)** BmK dITAP3, **(348)** BmK ANEP, **(349)** BmK AngM1, **(350)** BmK AS, **(351)** BmK AS-1, **(352)** BmK AGP-SYPU1, **(353)** BmK AGP-SYPU2, **(354)** BmK AGAP, **(355)** BmK AGAP-SYPU2 [108-110]등이 있다. 전갈의 antitumor peptide 들은 **(356)** BmK CT 와 **(357)** BmK CT-13 가 있는데, 이들의 아미노산 시퀀스는 항암제로 사용되고 있는 chlorotoxin 의 아미노산 시퀀스와 유사하다[111]. 특히, analgesic peptide 들 중에서 BmK AGAP 와 BmK AGAP-SYPU2 는 analgesic activity 와 antitumor activity 를 모두 가지고 있다. 이와 같은 두 타입의 bioactivity 이외에도, 전갈에서는 다음과 같이 antibacterial activity 를 가지는 두 성분들도 추출되었다 [112].




**(358)** 3β-acetoxyl,2,14,22-trihydroxy,19-hydroxymethyl,9α,5β,14β-card-20(22)enolide




**(359)** 1,2,3,4-tetrahydro-6-hydroxy1-5-pyrimidinecarbox-aldehyde

Figure 24. Chemical structures of cardiac glycoside and aldehyde identified from Scorpio.

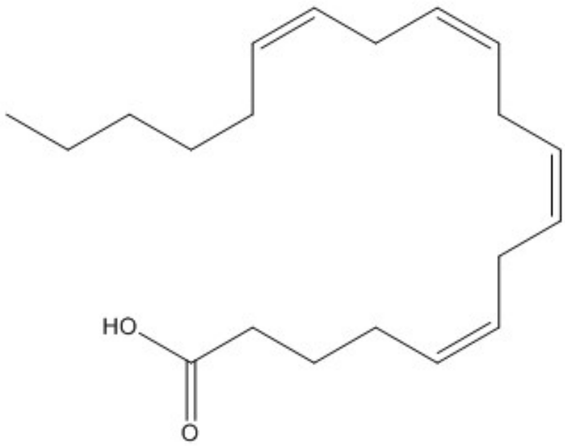
Lee et al. [113]의 연구에서는 전갈에서 **(360)** Asx, **(361)** Glx, **(178)** Ser, **(180)** His, **(181)** Gly, **(182)** Thr, **(183)** Arg, **(184)** Ala, **(185)** Tyr, **(362)** Cys, **(186)** Val, **(187)** Met, **(189)** Phe, **(190)** Ile, **(191)** Leu, **(192)** Lys, **(193)** Pro 의 17 개 아미노산을 추출하였다.

### 3.17. 제조(蠐螬), Holotrichia

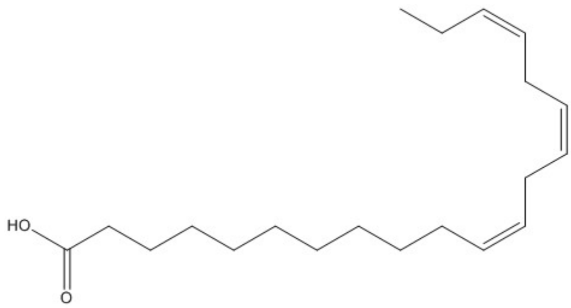
제조(蠐螬, Holotrichia)는 Melolonthidae 과에 속하는 풍뎅이(*Holotrichia diomphalia* Bates) 또는 기타 근연곤충의 유충이다. 제조의 hemolymph 에서는 곤충의 방어 작용과 상처 치료에 관여하는 **(363)** prophenoloxidase 가 추출되었다 [114]. 또한 제조에 함유되어 있는 **(340)** oleic acid, **(338)** palmitic acid, **(337)** palmitoleic acid 는 anti-inflammatory 와 analgesic activity 를 보인다고 알려져 있다 [115].

### 3.18. 지룡(地龍), Pheretima

지룡(地龍, Pheretima)은 지렁이(Megascolecidae 과에 속하는 *Pericaeta communisma* Gate et Hatai, *Pheretima aspergillum* E. Perrier, *P. vulgaris* Chen, *P. guillelmi* (Michaelsen), *P. pectinifera* Michaelsen. 또는, Lumbricidae 과에 속하는 *Allolobophora caliginosa* var. *trapezoides* Anton)의 몸체를 말린 것이다. **(364)** Lumbricin-PG 는 antimicrobial peptide 로써 *P. guillelmi* (Michaelsen)의 피부에서 추출되었다 [116]. Lumbricin-PG 는 59 개의 amino acid 를 가지며 6908.7 Da 의 분자량을 가지는데, 이는 *Lumbricus rubellus* 에서 추출된 antimicrobial peptide 인 lumbricin 과 유사하다. 이외에도 **(318)** hypoxanthine [117]과 **(340)** oleic acid, **(339)** linoleic acid, **(365)** arachidonic acid, **(366)** eicosatrienoic acid 과 같은 unsaturated fatty acid [118] 들도 *P. aspergillum* 에서 추출되었다.



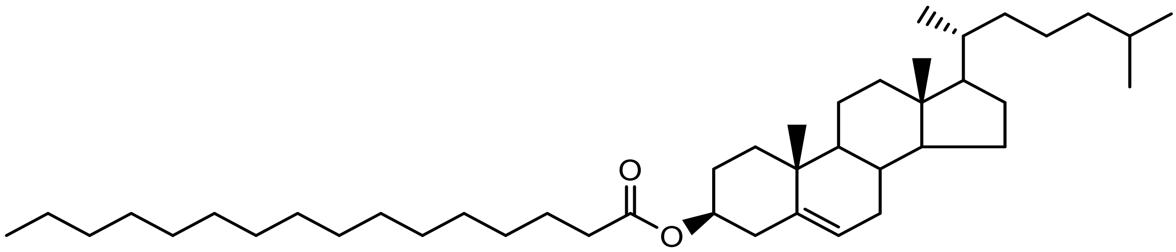
**(365)** arachidonic acid



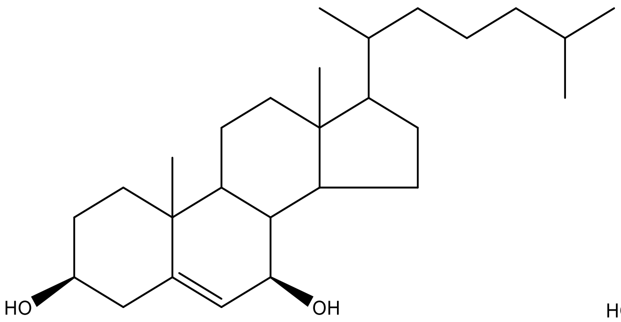
**(366)** eicosatrienoic acid

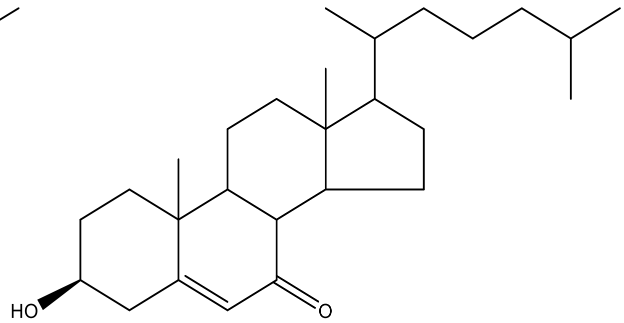
## 3.19. 합마유(哈蟆油), Ranae Oviductus

합마유(哈蟆油, Ranae Oviductus)는 Ranidae 과에 속하는 *Rana temporaria chensinensis* David 의 수란관을 말린 것이다. 아래 그림은 합마유에서 추출된 cholesteryl ester [119]들과 steroid [120]들을 보인 것이다.




**(367)** cholesteryl palmitate (PubChem 246520)




**(368)** cholest-5-en-3β,7β-diol (PubChem 473141)

**(369)** 3β-hydroxy-cholest-5-en-7-one

Figure 25. Chemical structures of a cholesteryl ester and steroids identified from Ranae Oviductus.

## 3.20. 해룡(海龍), Syngnathus

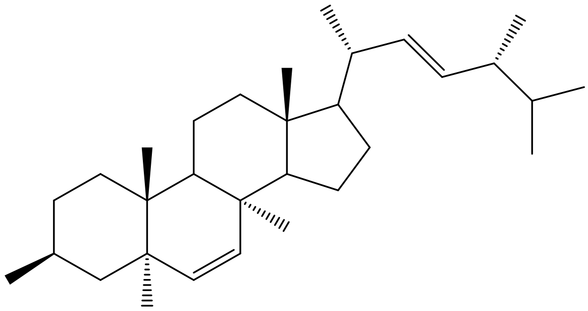
해룡(海龍, Syngnathus)은 Syngnathidae 과에 속하는 실고기(*Solenognathus hardwickii* (Gray), *Syngnathoides biaculeatus* (Bloch), *Syngnathus acus* Linnaeus)의 몸체를 말린 것이다. 최근, 해룡에서 translation-inhibiting activity 를 가지는 protein 인 **(370)** solenin 이 추출되었다 [121]. 이 protein 은 18 kD 의 분자량을 보이고 있으며 AHDAEVNEVKAQVAA 의 N-terminal sequence 를 가지고 있다. 또한, 해룡에서는 antioxidant 성분인 **(318)** hypoxanthine 도 추출되었다 [122].

## 3.21. 해마(海馬), Hippocampus

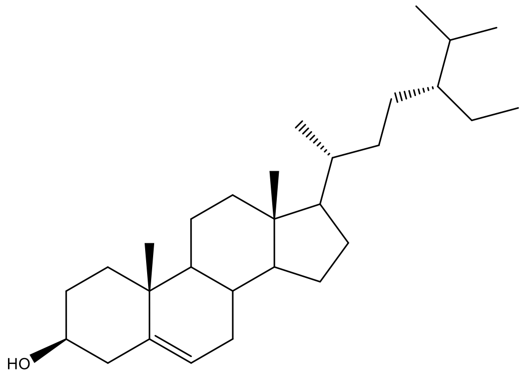
해마(海馬, Hippocampus)는 Syngnathidae 과에 속하는 해마(*Hippocampus coronatus* Temminck et Schlegel, *H. kelloggi* Jordan et Snyder, *H. histrix* Kaup, *H. kuda* Bleeker, *H. trimaculatus* Leach, *H. japonicus* Kaup)의 몸체를 말린 것이다. 해마의 구성 성분은 amino acid, peptide, glycoprotein, lipid, steroid 등을 포함하는 것으로 알려져 있다. Su et al. [123]은 *H. kuda* Bleeker 에서 두 개의 glycoproteins 인 **(371)** HG-11 과 **(372)** HG-21 를 추출하였다. 이 두 glycoprotein 에서 saccharide 함유량은 56.7975%와 39.479%였으며, protein 함유량은 30.5475%와 51.747%였다. Chen et al. [124]은 *H. trimaculatus* Leach 에서 anti-inflammatory activity 를 가지는 **(373)** lipid 들을 분리하였다. 이 lipid 들은 neutral lipid, glycolipid, phospholipid 들을 포함하며, 다양한 fatty acid 조합을 가지고 있다. 이 외에도 해마에는 **(318)** hypoxanthine 과 **(317)** xanthine 이 포함된 것으로 알려져 있다 [122, 125].

## 3.22. 백강잠(白殭蠶), Bombyx Batryticatus

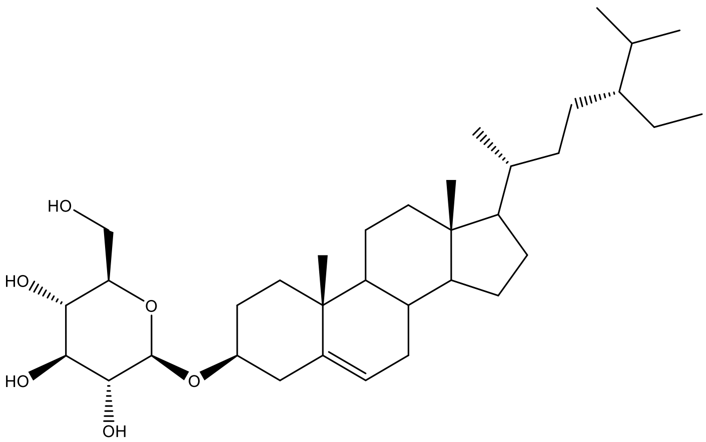
백강잠(白殭蠶, Bombyx Batryticatus)은 Bombycoidea 과에 속하는 누에(*Bombyx mori* L.) 유충이 *Beauveria bassiana* (Bals.) Vuillant 에 감염되어 경직사한 몸체이다. 백강잠의 성분은 sterol (**(374)** ergost-6,22-dien-3β,5α,8α-triol, **(375)** β-sitosterol, **(376)** daucosterol), sugar alcohol (**(377)**meso-erythritol, **(378)** D-mannitol), **(338)** palmitic acid, **(312)** uracil 등을 포함하는 것으로 알려져 있다 [126].



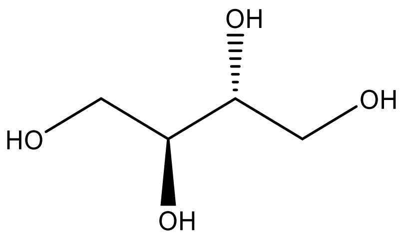
**(374)** ergost-6,22-dien-3β,5α,8α-triol



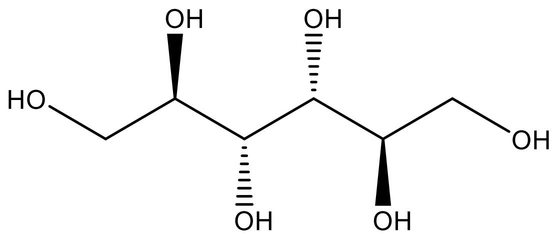

**(375)** β-sitosterol (PubChem 222284)




**(376)** daucosterol (PubChem 5742590)




**(377)** meso-erythritol (PubChem 222285)

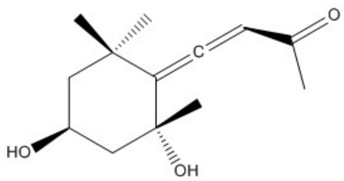



**(378)** D-mannitol (PubChem 6251)

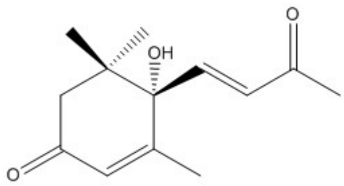
Figure 26. Chemical structures of sterols and alcohols identified from Bombyx Batryticatus.

## 3.23. 잠사(蠶沙), Bombycis Faeces

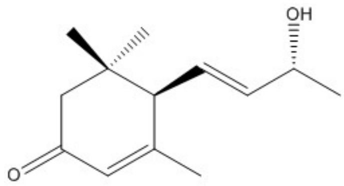
잠사(蠶沙, Bombycis Faeces)는 Bombycoidea 과에 속하는 누에(*Bombyx mori* L.) 유충의 분변을 말린 것이다. 잠사의 성분은 megastigmane sesquiterpene, megastigmane glycoside, carotenoid, alkaloid, amino acid 들을 포함하는 것으로 알려져 있다 [127-129]. 아래 그림은 잠사에서 식별된 5 개의 megastigmane sesquiterpene [127, 128], 5 개의 megastigmane sesquiterpene glycoside [127], lutein [127], 3 개의 alkaloid [129]들에 대한 화학 구조이다.



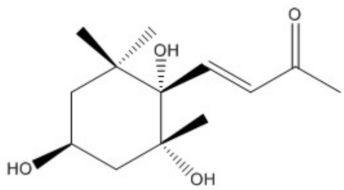
**(379)** (3S,5R,8R)-3,5-dihydroxymegastigma-6,7-dien-9-one



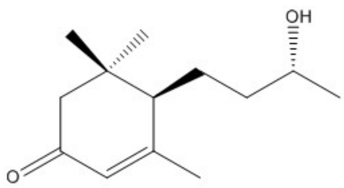
**(380)** (S)-dehydrovomifoliol (PubChem 688492)



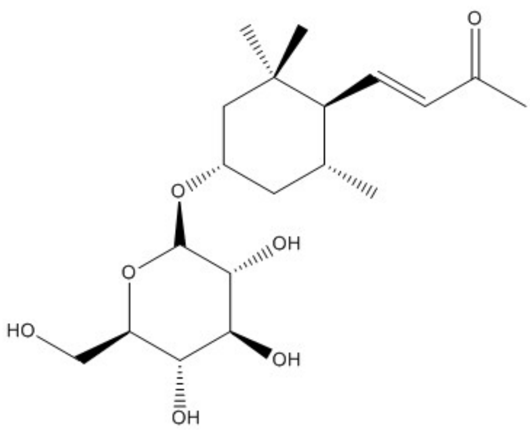
**(381)** (6R,7E,9R)-9-hydroxy-4,7-megastigmadien-3-one



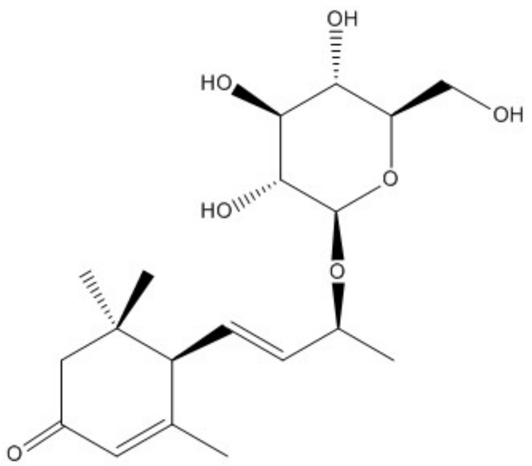
**(382)** (3S,5R,6S,7E)-3,5,6-trihydroxy-7-megastigmen-9-one



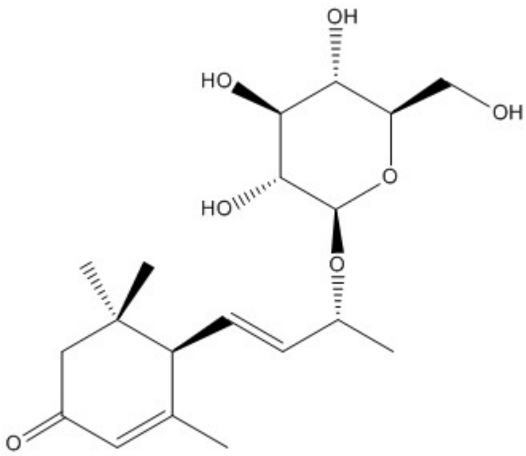
**(383)** (6R,9R)-9-hydroxy-4-megastigmen-3-one



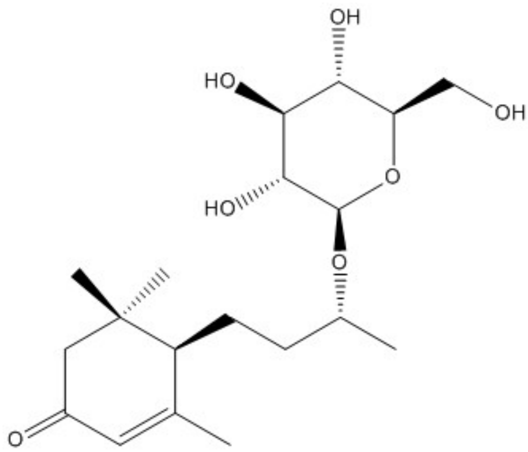
**(384)** alangionoside L (PubChem 98789413)



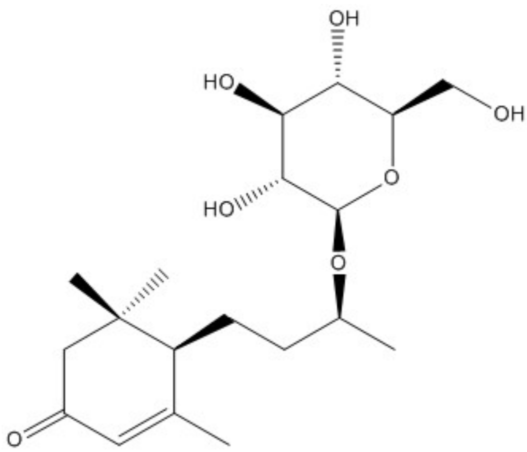
**(385)** (6R,9R)-3-oxo-α-ionol-β-D-glucopyranoside



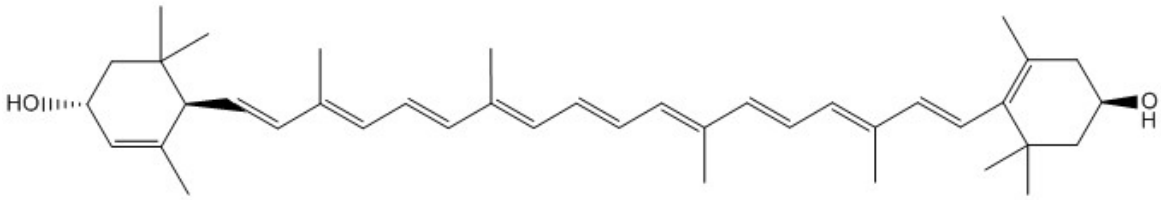
**(386)** (6R,9S)-3-oxo-α-ionol-β-D-glucopyranoside



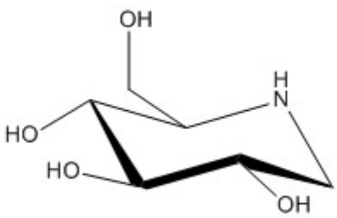
**(387)** byzantionoside B (PubChem 14135395)



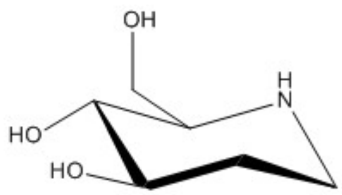
**(388)** blumenol C glucoside
(PubChem 14135395)



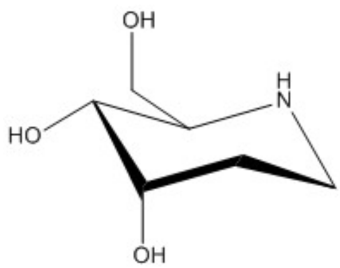
**(389)** lutein (PubChem 5281243)



**(390)** 1-deoxynojirimycin
(PubChem 29435)



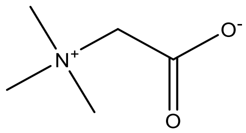
**(391)** fagomine
(PubChem 72259)



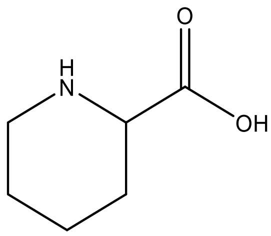
**(392)** 3-epifagomine
(PubChem 10290867)

Figure 27. Chemical structures of sesquiterpenes, sesquiterpene glycosides, lutein, and alkaloids identified from Bombycis Faeces.

이외에도 잠사에는 amino acid (Ala, Glx, Phe, Leu, Ile)들과 amino acid derivative 인 **(393)** betaine, lysine metabolite 인 **(394)** pipecolic acid 도 추출되었다 [127].




**(393)** betaine (PubChem 247)

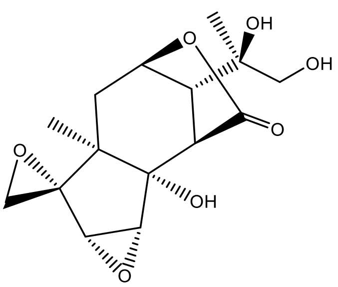



**(394)** pipecolic acid (PubChem 849)

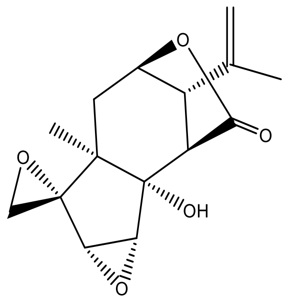
Figure 28. Chemical structures of betaine and pipecolic acid identified from Bombycis Faeces.

## 3.24. 노봉방(露蜂房), Vespae Nidus

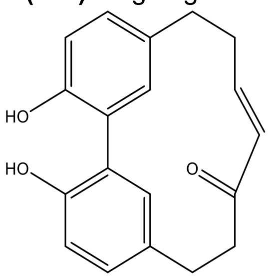
노봉방(露蜂房, Vespae Nidus)은 Vespidae 과의 말벌(*Polistes mandarinus* Saussure et Geer, *P. olivaceous* (DeGeer), *P. japonicus* Saussure, *Parapolybia varia* Fabricius)이 만든 집이다. 최근 노봉방에서는 두 개의 sesquiterpenoid 과 여섯 개의 diarylheptanoid 가 추출되었다 [130].



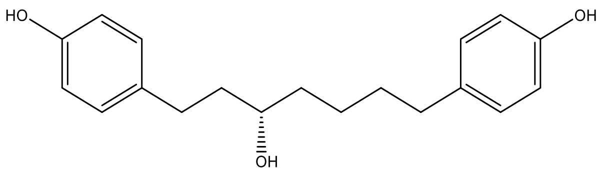
**(395)** fengfangin A



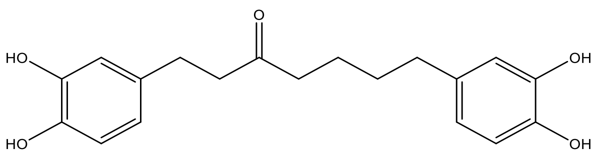
**(396)** tutin (PubChem 75729)



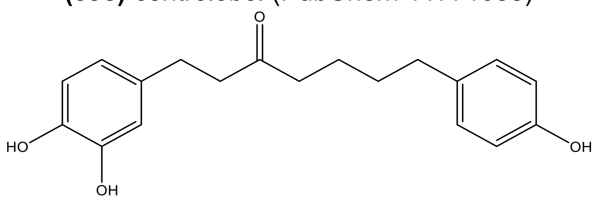
**(397)** alnusone



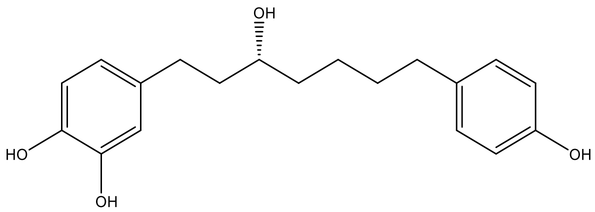
**(398)** centrolobol (PubChem 11771038)



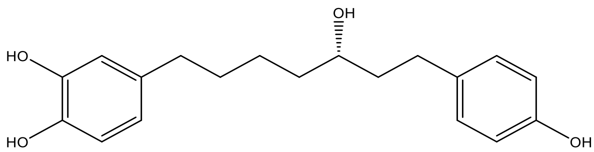
**(399)** muricarpone B (PubChem 11573476)



**(400)** 1-(3,4-dihydroxyphenyl)-7-(4-hydroxyphenyl)heptan-3-one



**(401)** (3S)-1-(3,4-dihydroxyphenyl)-7-(4-hydroxyphenyl)heptan-3-ol



**(402)** (3S)-1-(4-hydroxyphenyl)-7-(3,4-dihydroxyphenyl)heptan-3-ol

Figure 29. Chemical structures of sesquiterpenoids and diarylheptanoids identified from Vespae Nidus.

### 3.25. 상표초(桑螵蛸), Mantidis Oötheca

상표초(桑螵蛸, Mantidis Oötheca)는 Mantidae 과에 속하는 사마귀(*Tenodera angustipennis* Saussure, *T. sinensis* Saussure, *Statilia maculata* (Thunberg), *Hierodula patellifera* (Serville))의 알집을 찐 다음 말린 것이다. 상표초는 fibrinolytic activity 를 가지는 protease 를 가지고 있다. 32.8k Da 의 분자량을 가지는 **(403)** mantis-egg fibrolase (MEF) [131] 가 발견된 이후로 유사한 fibrinolytic protease 인 **(404)** MEF-2 (32.9k Da)와 **(405)** MEF-3 (35.6k Da)가 상표초에서 추출되었다 [132].

## 3.26. 석결명(石決明), Haliotidis Concha

석결명(石決明, Haliotidis Concha)은 Haliotidae 과에 속하는 *Nardotis gigantea* (Gmelin), *Sulculus diversicolor supertexta* (Lischke), *Haliotis diversicolor* Reeve, *H. discus hannai* Ino, *H. ovina* Gmelin, *H. ruber* (Leach), *H. asinina* Linnaeus, *H. laevigata* (Donovan)의 조개껍질이다. 석결명을 구성하는 성분의 90% 이상은 calcium carbonate 이며, 이외에 유기 또는 비유기 물질들도 포함되어 있다. 최근, *H. laevigata* 의 껍질에서 **(406)** perlucin (17k Da)과 **(407)** perlustrin (13k Da)의 두 개의 protein 이 추출되었으며 [133], *H. discus hannai* Ino 의 껍질에서는 polyenic 화합물인 **(408)** aquamarine blue pigment 가 추출되었다 [134].

### 3.27. 와릉자(瓦楞子), Arcae Concha

와릉자(瓦楞子, Arcae Concha)는 Arcidae 과에 속하는 *Scapharca subcrenata* (Lischke), *S. broughtonii* Schrenck, *Tegillarca granosa* (Linne), *Arca subcrenata* Lischke, *A. granosa* Linnaeus, *A. inflata* Reeve 의 조개껍질이다. 와릉자의 주요 성분은 calcium carbonate 이며, 최근 *S. subcrenata* 의 alcalase hydrolysate 에서 **(409)** A-Bg1 과 **(410)** A-Bh 의 두 antioxidant peptide 가 추출되었다 [135].

### 3.28. 진주모(珍珠母), Margaritifera Concha, 진주(珍珠), Margarita

진주모(珍珠母, Margaritifera Concha, mother of pearl or nacre)는 Unionidae 과에 속하는 *Hyriopsis cumingii* (Lea), *Cristaria plicata* (Leach)의 조개껍질, 또는 Pteriidae 과에 속하는 *Pteria martensii* (Dunker), *Pinctada fucata martensii* (Dunker)의 조개껍질이다. 그리고, 진주(珍珠, Margarita, pearl)는 이 조개들이 자극을 받아 생성한 구슬이다. 진주모와 진주의 주요 성분은 석결명과 와릉자와 같이 calcium carbonate 이며, 이외에 organic compound 로써 **(411)** water-soluble proteins, **(412)** acid soluble proteins, **(413)** acid insoluble proteins, **(414)** conchiolin protein 들이 진주모와 진주에서 추출되었다 [136, 137].

### 3.29. 용골(龍骨), Fossilia Ossis Mastodi

용골(龍骨), Fossilia Ossis Mastodi, Longgu)은 커다란 포유동물의 화석화된 뼈이다. 용골은 생산할 수 있는 것이 아니어서 양이 매우 제한적이지만, 전통의학에서는 수 천년 넘게 약재로 이용되어 왔다. 용골의 주요 성분은 aragonite 타입의 **(415)** calcium carbonate 와 **(416)** hydroxyapatite 이며, 16 개의 원소인 **(417)** Al, **(418)** Ba, **(419)** Bi, **(420)** Ca, **(421)** Ge, **(422)** I, **(423)** Ir, **(424)** K, **(425)** Mn, **(426)** Mo, **(427)** Na, **(428)** Ni, **(429)** Si, **(430)** V, **(431)** Zn, **(432)** Zr 들도 포함하는 것으로 알려져 있다 [138].

# 4. 맺음말

전통 의학에서 약재의 구성 성분에 대한 연구들은 주로 식물 약재들에 대해서 수행되어 왔으며, 현재 여러 전통의학 데이터베이스에서 식물 약재들에 대한 많은 구성 성분 정보가 제공되고 있다. 반면에 동물, 조개껍질, 미네랄 등을 포함하는 비식물 약재들도 옛날부터 임상에서 많이 이용되어 왔지만, 비식물 약재의 구성 성분에 대한 정보의 양은 식물 약재보다 훨씬 적다. 따라서, 비식물 약재의 구성 성분에 대한 정보를 체계적으로 구축할 필요가 있다. 일반적으로 약재에 대한 systematic review 에서 약재의 구성 성분을 조사하는 경우, PubMed, Scopus, Web of Science, Google Scholar 등 다양한 데이터베이스에서 약재들을 검색한다. 또한 TCM 의 경우에는 중국어로 된 중국 데이터베이스를 검색하기도 한다. 하지만 일반적으로 하나의 약재에 대해서 모든 문헌을 review 하는 데도 오랜 시간이 걸리는데, 수백 개의 비식물 약재를 전부 review 하기에는 엄청난 시간이 소요될 수 있다. 약재를 연구할 때, 이러한 시간적인 문제 때문에 보통 기존에 구축된 데이터베이스를 검색하기도 하지만, 일부 비식물 약재의 경우 데이터베이스에 존재하지 않으며, 또한 기존 데이터베이스가 기존의 출판된 서적을 참고해서 만들어져서 최신 연구 결과까지 포함하지 못하는 문제가 있다. 더군다나, 일반적으로 약재의 구성 성분은 약재의 기원과 화합물의 추출 방법에 따라서 달라지는데, 비식물 약재는 식물 약재의 경우보다 이런 차이가 많이 나기 때문에 서적에서 제공하는 성분 정보에 추가로 상세한 재료 및 방법을 원래의 논문에서 참고할 필요가 있다. 또한 원래의 논문을 찾아보려고 할 때, 오프라인 서적의 경우 온라인 데이터베이스에 비해 검색하고 원문을 얻기가 쉽지 않다.

따라서, 본 도서에서는 비식물 약재의 구성 성분에 대한 정보를 체계적으로 구축하기 위한 하나의 시도로써 온라인 데이터베이스들 중의 하나인 PubMed 에 존재하는 chromatography article 에서 비식물 약재의 구성 성분들을 조사해 정리하였다. 현재는 PubMed 데이터베이스 하나만 검색을 했기 때문에 개별 약재별로 조사된 구성성분 정보의 양은 모든 데이터베이스를 검색하는 경우보다 적을 수 있으나, 반면에 PubMed 데이터베이스에서 모든 비식물 약재들에 대해서 구성성분을 조사할 수 있었다. 일반적으로 약재에 대한 review 는 지금까지 어느 정도 연구가 이루어진 약재를 대상으로 수행된다. 하지만 본 도서에서는 어느 정도 연구가 이루어진 약재뿐만 아니라 연구가 거의 없는 약재들에 대해서도 조사하였다. 따라서, 여기에서 조사한 화합물들이 기존에 알려지지 않은 새로운 화합물들은

아니다. 대신, PubMed 데이터베이스에 존재하는 전통의학 분야의 비식물 약재의 구성성분에 대한 현재 시점의 조사 결과를 제공하는 점에 의미가 있다.

본 도서에서는 TM-MC 와 같이 chromatography 논문들만 필터링하였다. Chromatography 는 mixture 들을 분리하기 위해 사용되는 일반적인 실험 방법이기 때문에 약재의 화합물에 대한 대부분의 논문들이 검색되었지만 필터링되지 않은 논문들도 존재할 수 있다. 따라서 향후에는 데이터베이스의 완성도를 높이기 위해서 다른 스크리닝 방법을 필터링하거나 모든 약재에 대한 논문을 검토하는 것이 필요하다.

PubMed 의 article 에서 한국, 중국, 일본 약전에 나오는 식물 약재의 구성성분 정보는 이미 TM-MC 에서 제공되고 있다. 하지만, TM-MC 의 경우 화합물의 이름을 식별자로 이용하다 보니 중복된 화합물에 대한 정보가 존재하였으며, 현재 TM-MC 에서 이러한 중복 문제를 해결하고 있다. 이와 별도의 작업으로 본 도서에서는 모든 비식물 약재의 구성 성분에 대해서 화학 구조식을 식별자로 이용해서 화합물들간에 중복이 없도록 하였다. 또한 PubChem Compound 데이터베이스에 있는 화합물인 경우 PubChem 의 ID 까지 제공해서 사용자가 PubChem 으로부터 더 많은 정보를 얻을 수 있도록 하였다.

# 부록 1. 약재의 구성성분 리스트

| No | Latin name | Compound | Class |
|---|---|---|---|
| 1 | Bufonis Venenum | resibufogenin (bufogenin) | steroid |
| 2 | Bufonis Venenum | 3-epi-resibufogenin | steroid |
| 3 | Bufonis Venenum | resibufagin | steroid |
| 4 | Bufonis Venenum | desacetylcinobufagin | steroid |
| 5 | Bufonis Venenum | marinobufagin | steroid |
| 6 | Bufonis Venenum | bufotalinin | steroid |
| 7 | Bufonis Venenum | desacetylcinobufotalin (de-O-acetylcinobufotalin) | steroid |
| 8 | Bufonis Venenum | 11-hydroxyresibufogenin | steroid |
| 9 | Bufonis Venenum | 12β-hydroxyresibufogenin | steroid |
| 10 | Bufonis Venenum | 19-oxo-desacetylcinobufagin | steroid |
| 11 | Bufonis Venenum | 22,23-epoxyresibufogenin | steroid |
| 12 | Bufonis Venenum | resibufaginol | steroid |
| 13 | Bufonis Venenum | cinobufagin | steroid |
| 14 | Bufonis Venenum | cinobufaginol | steroid |
| 15 | Bufonis Venenum | cinobufotalin | steroid |
| 16 | Bufonis Venenum | 22,23-epoxycinobufotalin | steroid |
| 17 | Bufonis Venenum | 3-oxo-cinobufagin | steroid |
| 18 | Bufonis Venenum | 3-oxo-cinobufotalin | steroid |
| 19 | Bufonis Venenum | 12β-hydroxycinobufagin | steroid |
| 20 | Bufonis Venenum | 5,12β-dihydroxycinobufagin | steroid |
| 21 | Bufonis Venenum | 19-oxo-cinobufagin | steroid |
| 22 | Bufonis Venenum | 19-oxo-cinobufotalin | steroid |
| 23 | Bufonis Venenum | resibufogenin-3-O-succinate-arginine | steroid |

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|---|---|---|---|
| 24 | Bufonis Venenum | resibufaginol-3-O-succinate-arginine | steroid |
| 25 | Bufonis Venenum | cinobufagin-3-O-succinate-arginine | steroid |
| 26 | Bufonis Venenum | cinobufaginol-3-O-succinate-arginine | steroid |
| 27 | Bufonis Venenum | resibufogenin-3-O-glutarate-arginine | steroid |
| 28 | Bufonis Venenum | cinobufagin-3-O-glutarate-arginine | steroid |
| 29 | Bufonis Venenum | marinobufotoxin (marinobufagin 3-suberoylarginine ester) | steroid |
| 30 | Bufonis Venenum | cinobufagin-3-O-adipate-arginine | steroid |
| 31 | Bufonis Venenum | 19-oxo-cinobufotalin-3-O-adipate-arginine | steroid |
| 32 | Bufonis Venenum | resibufogenin-3-O-pimelate-arginine | steroid |
| 33 | Bufonis Venenum | cinobufagin-3-O-pimelate-arginine | steroid |
| 34 | Bufonis Venenum | cinobufaginol-3-O-pimelate-arginine | steroid |
| 35 | Bufonis Venenum | cinobufotalitoxin | steroid |
| 36 | Bufonis Venenum | resibufogenin-3-O-suberate | steroid |
| 37 | Bufonis Venenum | cinobufagin-3-O-suberate | steroid |
| 38 | Bufonis Venenum | resibufotoxin (resibufogenin-3-O-suberate-arginine) | steroid |
| 39 | Bufonis Venenum | cinobufotoxin (cinobufagin-3-O-suberate-arginine) | steroid |
| 40 | Bufonis Venenum | cinobufaginol-3-O-suberate-arginine | steroid |
| 41 | Bufonis Venenum | 19-oxo-cinobufotalin-3-O-suberate-arginine | steroid |
| 42 | Bufonis Venenum | 19-oxo-cinobufotalin-3-O-suberate-methylhistidine | steroid |
| 43 | Bufonis Venenum | cinobufagin-3-O-nonanedioic-arginine | steroid |
| 44 | Bufonis Venenum | bufotalinin-3-O-sebacate-arginine | steroid |
| 45 | Bufonis Venenum | bufalin | steroid |
| 46 | Bufonis Venenum | 1β-hydroxybufalin | steroid |

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|---|---|---|---|
| 47 | Bufonis Venenum | 19-oxo-bufalin | steroid |
| 48 | Bufonis Venenum | 19-hydroxybufalin | steroid |
| 49 | Bufonis Venenum | gamabufotalin | steroid |
| 50 | Bufonis Venenum | telocinobufagin | steroid |
| 51 | Bufonis Venenum | 11α-hydroxytelocinobufagin | steroid |
| 52 | Bufonis Venenum | hellebrigenin | steroid |
| 53 | Bufonis Venenum | hellebrigenol (19-hydroxytelocinobufagin) | steroid |
| 54 | Bufonis Venenum | arenobufagin | steroid |
| 55 | Bufonis Venenum | bufarenogin | steroid |
| 56 | Bufonis Venenum | φ-bufarenogin (ψ-bufarenogin) | steroid |
| 57 | Bufonis Venenum | bufalone | steroid |
| 58 | Bufonis Venenum | desacetylbufotalin | steroid |
| 59 | Bufonis Venenum | bufotalin | steroid |
| 60 | Bufonis Venenum | 5-hydroxybufotalin | steroid |
| 61 | Bufonis Venenum | 16-O-acetylarenobufagin | steroid |
| 62 | Bufonis Venenum | 16-acetoxybufarenogin | steroid |
| 63 | Bufonis Venenum | gamabufotalin-3-O-sulfate | steroid |
| 64 | Bufonis Venenum | arenobufagin-3-O-sulfate | steroid |
| 65 | Bufonis Venenum | bufotalin-3-O-sulfate | steroid |
| 66 | Bufonis Venenum | 19-hydroxybufalin-3-O-sulfate | steroid |
| 67 | Bufonis Venenum | telocinobufagin-3-O-sulfate | steroid |
| 68 | Bufonis Venenum | desacetylbufotalin-3-O-sulfate | steroid |
| 69 | Bufonis Venenum | hellebrigenin-3-O-sulfate | steroid |
| 70 | Bufonis Venenum | hellebrigenol-3-O-sulfate | steroid |

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|---|---|---|---|
| 71 | Bufonis Venenum | gamabufotalin-3-oxalate | steroid |
| 72 | Bufonis Venenum | bufalin-3-O-suberate | steroid |
| 73 | Bufonis Venenum | gamabufotalin-3-O-suberate | steroid |
| 74 | Bufonis Venenum | bufalin-3-O-succinate-arginine | steroid |
| 75 | Bufonis Venenum | gamabufotalin-3-O-succinate-arginine | steroid |
| 76 | Bufonis Venenum | bufalone-3-O-succinate-arginine | steroid |
| 77 | Bufonis Venenum | bufotalin-3-O-succinate-arginine | steroid |
| 78 | Bufonis Venenum | bufotalin-3-O-glutarate-arginine | steroid |
| 79 | Bufonis Venenum | bufalin-3-O-glutarate-arginine | steroid |
| 80 | Bufonis Venenum | bufalin-3-O-adipate-arginine | steroid |
| 81 | Bufonis Venenum | gamabufotalin-3-O-adipate-arginine | steroid |
| 82 | Bufonis Venenum | gamabufotalin-3-O-pimelate-arginine | steroid |
| 83 | Bufonis Venenum | bufalin-3-O-pimelate-arginine | steroid |
| 84 | Bufonis Venenum | bufotalin-3-O-pimelate-arginine | steroid |
| 85 | Bufonis Venenum | gamabufotalitoxin (gamabufotalin-3-O-suberate-arginine) | steroid |
| 86 | Bufonis Venenum | arenobufotoxin | steroid |
| 87 | Bufonis Venenum | bufotalin-3-O-suberate-arginine | steroid |
| 88 | Bufonis Venenum | bufotalin-3-O-suberate-histidine | steroid |
| 89 | Bufonis Venenum | bufalin-3-O-suberate-methylhistidine | steroid |
| 90 | Bufonis Venenum | bufalitoxin | steroid |
| 91 | Bufonis Venenum | telocinobufatoxin (telocinobufagin-3-O-suberate-arginine) | steroid |
| 92 | Bufonis Venenum | hellebritoxin (hellebrigenin-3-O-suberate-arginine) | steroid |
| 93 | Bufonis Venenum | bufotoxin | steroid |

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|---|---|---|---|
| 94 | Bufonis Venenum | 3β,14β,19β-trihydroxybufa-20,22-dienolide; 3-O-suberate-L-histidine | steroid |
| 95 | Bufonis Venenum | gamabufotalin-3-O-pelargonate-arginine | steroid |
| 96 | Bufonis Venenum | bufalin-3-O-sebacate-arginine | steroid |
| 97 | Bufonis Venenum | argentinogenin | steroid |
| 98 | Bufonis Venenum | argentinogenin-3-O-adipate-arginine | steroid |
| 99 | Bufonis Venenum | hellebrigenol-9,11-ene | steroid |
| 100 | Bufonis Venenum | 3-dehydroscillarenin | steroid |
| 101 | Bufonis Venenum | scillarenin-3-pimelate-arginine | steroid |
| 102 | Bufonis Venenum | scillarenin-3-suberate-arginine | steroid |
| 103 | Bufonis Venenum | 3β,16β-dihydroxybufa-8(14),20,22-trienolide | steroid |
| 104 | Bufonis Venenum | 14,16-dihydroxybufa-5,20,22-trienolide; (14β,16β)-form, 16-Ac | steroid |
| 105 | Bufonis Venenum | serotonin | alkaloid |
| 106 | Bufonis Venenum | N-methylserotonin | alkaloid |
| 107 | Propolis | cinnamic acid | phenolic |
| 108 | Propolis | 3,4-dimethoxycinnamic acid (3,4-dimethylcaffeic acid) | phenolic |
| 109 | Propolis | ferulic acid | phenolic |
| 110 | Propolis | isoferulic acid | phenolic |
| 111 | Propolis | p-coumaric acid | phenolic |
| 112 | Propolis | p-coumaric acid benzyl ester | phenolic |
| 113 | Propolis | caffeic acid | phenolic |
| 114 | Propolis | caffeic acid benzyl ester (benzyl caffeate) | phenolic |
| 115 | Propolis | caffeic acid phenethyl ester (phenethyl caffeate) | phenolic |
| 116 | Propolis | caffeic acid isoprenyl ester | phenolic |

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|---|---|---|---|
| 117 | Propolis | caffeic acid cinnamyl ester (cinnamyl caffeate) | phenolic |
| 118 | Propolis | p-methoxycinnamic acid cinnamyl ester | phenolic |
| 119 | Propolis | gallic acid | phenolic |
| 120 | Propolis | resveratrol | phenolic |
| 121 | Propolis | cinnamylidene acetic acid | phenolic |
| 122 | Propolis | chrysin | flavonoid |
| 123 | Propolis | tectochrysin (chrysin 7-methyl ether) | flavonoid |
| 124 | Propolis | apigenin | flavonoid |
| 125 | Propolis | luteolin | flavonoid |
| 126 | Propolis | luteolin 5-methyl ether | flavonoid |
| 127 | Propolis | acacetin | flavonoid |
| 128 | Propolis | baicalin | flavonoid |
| 129 | Propolis | galangin | flavonoid |
| 130 | Propolis | galangin 5-methyl ether | flavonoid |
| 131 | Propolis | fisetin | flavonoid |
| 132 | Propolis | quercetin | flavonoid |
| 133 | Propolis | quercetin 3-methyl ether | flavonoid |
| 134 | Propolis | quercetin 5,7-dimethyl ether | flavonoid |
| 135 | Propolis | rutin | flavonoid |
| 136 | Propolis | kaempferol | flavonoid |
| 137 | Propolis | isorhamnetin | flavonoid |
| 138 | Propolis | kaempferide | flavonoid |
| 139 | Propolis | izalpinin | flavonoid |
| 140 | Propolis | morin | flavonoid |

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|---|---|---|---|
| 141 | Propolis | myricetin | flavonoid |
| 142 | Propolis | pinocembrin | flavonoid |
| 143 | Propolis | pinocembrin 5-methyl ether | flavonoid |
| 144 | Propolis | pinocembrin 7-methyl ether (pinostrobin) | flavonoid |
| 145 | Propolis | pinobanksin | flavonoid |
| 146 | Propolis | pinobanksin 5-methyl ether | flavonoid |
| 147 | Propolis | pinobanksin 7-methyl ether | flavonoid |
| 148 | Propolis | pinobanksin 3-O-acetate | flavonoid |
| 149 | Propolis | pinobanksin 3-O-propionate | flavonoid |
| 150 | Propolis | pinobanksin 3-O-butyrate | flavonoid |
| 151 | Propolis | pinobanksin 3-O-isobutyrate | flavonoid |
| 152 | Propolis | pinobanksin 3-O-pentanoate | flavonoid |
| 153 | Propolis | pinobanksin 3-O-(2-methyl)butyrate | flavonoid |
| 154 | Propolis | naringenin | flavonoid |
| 155 | Propolis | hesperetin | flavonoid |
| 156 | Propolis | catechin | flavonoid |
| 157 | Propolis | genistein | flavonoid |
| 158 | Propolis | nicotinic acid | alkaloid |
| 159 | Propolis | (-)-2-acetyl-1-(E)-feruloyl-3-(3''(ζ),16'')-dihydroxy-palmitoylglycerol | ester |
| 160 | Propolis | 2-acetyl-1,3-dicaffeoylglycerol | ester |
| 161 | Propolis | 2-acetyl-1-caffeoyl-3-coumaroylglycerol | ester |
| 162 | Propolis | 2-acetyl-1-feruloyl-3-caffeoylglycerol | ester |
| 163 | Propolis | 2-acetyl-1-feruloyl-3-coumaroylglycerol | ester |

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| 164 | Propolis | 2-acetyl-1,3-diferuloylglycerol | ester |
| 165 | Propolis | (-)-2-acetyl-1-caffeoyl-3-cinnamoylglycerol | ester |
| 166 | Propolis | (+)-2-acetyl-1-caffeoyl-3-cinnamoylglycerol | ester |
| 167 | Propolis | 2-acetyl-1-coumaroyl-3-cinnamoylglycerol | ester |
| 168 | Propolis | (+)-2-acetyl-1-feruloyl-3-cinnamoylglycerol | ester |
| 169 | Propolis | (-)-2-acetyl-1-feruloyl-3-cinnamoylglycerol | ester |
| 170 | Propolis | 2-acetyl-1,3-dicinnamoylglycerol | ester |
| 171 | Mel | protocatechuic acid | phenolic |
| 172 | Mel | p-hydroxybenzoic acid | phenolic |
| 173 | Mel | syringic acid | phenolic |
| 174 | Mel | chlorogenic acid | phenolic |
| 175 | Mel | kampferol | flavonoid |
| 113 | Mel | caffeic acid | phenolic |
| 109 | Mel | ferulic acid | phenolic |
| 111 | Mel | p-coumaric acid | phenolic |
| 115 | Mel | caffeic acid phenethyl ester (phenethyl caffeate) | phenolic |
| 119 | Mel | gallic acid | phenolic |
| 122 | Mel | chrysin | flavonoid |
| 124 | Mel | apigenin | flavonoid |
| 129 | Mel | galangin | flavonoid |
| 132 | Mel | quercetin | flavonoid |
| 135 | Mel | rutin | flavonoid |
| 140 | Mel | morin | flavonoid |
| 141 | Mel | myricetin | flavonoid |

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|---|---|---|---|
| 142 | Mel | pinocembrin | flavonoid |
| 154 | Mel | naringenin | flavonoid |
| 176 | Mel | Asp | amino acid |
| 177 | Mel | Glu | amino acid |
| 178 | Mel | Ser | amino acid |
| 179 | Mel | Gln | amino acid |
| 180 | Mel | His | amino acid |
| 181 | Mel | Gly | amino acid |
| 182 | Mel | Thr | amino acid |
| 183 | Mel | Arg | amino acid |
| 184 | Mel | Ala | amino acid |
| 185 | Mel | Tyr | amino acid |
| 186 | Mel | Val | amino acid |
| 187 | Mel | Met | amino acid |
| 188 | Mel | Trp | amino acid |
| 189 | Mel | Phe | amino acid |
| 190 | Mel | Ile | amino acid |
| 191 | Mel | Leu | amino acid |
| 192 | Mel | Lys | amino acid |
| 193 | Mel | Pro | amino acid |
| 194 | Stichopus | holothurin A1 | terpenoid |
| 195 | Stichopus | holothurin A | terpenoid |
| 196 | Stichopus | echinoside A | terpenoid |
| 197 | Stichopus | 24-dehydroechinoside A | terpenoid |

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| 198 | Stichopus | pervicoside C | terpenoid |
| 199 | Stichopus | holothurinoside A | terpenoid |
| 200 | Stichopus | 17-dehydroxyholothurinoside A | terpenoid |
| 201 | Stichopus | cladoloside B | terpenoid |
| 202 | Stichopus | holothurin B2 | terpenoid |
| 203 | Stichopus | holothurin B | terpenoid |
| 204 | Stichopus | holotoxin A | terpenoid |
| 205 | Stichopus | holotoxin B | terpenoid |
| 206 | Stichopus | holotoxin $A_1$ | terpenoid |
| 207 | Stichopus | holotoxin $B_1$ | terpenoid |
| 208 | Stichopus | bivittoside C | terpenoid |
| 209 | Stichopus | frondoside A2 | terpenoid |
| 210 | Stichopus | frondoside A | terpenoid |
| 211 | Stichopus | fucosylated chondroitin sulfate | glycoprotein |
| 212 | Stichopus | cerebroside | lipid |
| 213 | Stichopus | ganglioside | lipid |
| 214 | Stichopus | major yolk protein | protein |
| 215 | Stichopus | actin | protein |
| 216 | Stichopus | melanotransferrin | protein |
| 217 | Stichopus | complement component3-2 | protein |
| 218 | Stichopus | arginine kinase | protein |
| 219 | Stichopus | heat shock protein gp 96 | protein |
| 220 | Stichopus | heat shock protein 90 | protein |
| 221 | Stichopus | translation elongation factor | protein |

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|---|---|---|---|
| 222 | Stichopus | myosin heavy chain, striated muscle-like isoform3 | protein |
| 223 | Stichopus | spectrin alphachain | protein |
| 224 | Stichopus | peroxiredoxin-6 | protein |
| 225 | Stichopus | proprotein convertase subtilisin/kexin type9 | protein |
| 226 | Stichopus | 60S ribosomal protein L32e | protein |
| 227 | Stichopus | cathepsin L-associated protein | protein |
| 228 | Stichopus | 40S ribosomal protein S3-like | protein |
| 229 | Stichopus | aldehyde dehydrogenase,mitochondrial-like | protein |
| 230 | Stichopus | neurobeachin-like | protein |
| 231 | Stichopus | alpha-centractin-like | protein |
| 232 | Stichopus | adenosine | nucleoside |
| 233 | Stichopus | ethyl-α-D-glucopyranoside | saccharide |
| 234 | Bovis Calculus | cholic acid | steroid |
| 235 | Bovis Calculus | deoxycholic acid | steroid |
| 236 | Bovis Calculus | chenodeoxycholic acid | steroid |
| 237 | Bovis Calculus | hyodeoxycholic acid | steroid |
| 238 | Bovis Calculus | ursodeoxycholic acid | steroid |
| 241 | Bovis Calculus | glycocholic acid | steroid |
| 242 | Bovis Calculus | glycodeoxycholic acid | steroid |
| 243 | Bovis Calculus | glycochenodeoxycholic acid | steroid |
| 247 | Bovis Calculus | taurocholic acid | steroid |
| 248 | Bovis Calculus | taurodeoxycholic acid | steroid |
| 249 | Bovis Calculus | taurochenodeoxycholic acid | steroid |
| 256 | Bovis Calculus | bilirubin | other |

| | | | |
|---|---|---|---|
| 257 | Bovis Calculus | 7β-hydroxycholesterol | steroid |
| 258 | Bovis Calculus | 25-hydroxycholesterol | steroid |
| 259 | Bovis Calculus | 5,6α-epoxycholesterol | steroid |
| 260 | Bovis Calculus | 5,6β-epoxycholesterol | steroid |
| 261 | Bovis Calculus | cholestane-3β,5α,6β-triol | steroid |
| 234 | Bovis Calculus Artifactus | cholic acid | steroid |
| 235 | Bovis Calculus Artifactus | deoxycholic acid | steroid |
| 236 | Bovis Calculus Artifactus | chenodeoxycholic acid | steroid |
| 237 | Bovis Calculus Artifactus | hyodeoxycholic acid | steroid |
| 238 | Bovis Calculus Artifactus | ursodeoxycholic acid | steroid |
| 239 | Bovis Calculus Artifactus | lithocholic acid | steroid |
| 241 | Bovis Calculus Artifactus | glycocholic acid | steroid |
| 242 | Bovis Calculus Artifactus | glycodeoxycholic acid | steroid |
| 243 | Bovis Calculus Artifactus | glycochenodeoxycholic acid | steroid |
| 246 | Bovis Calculus Artifactus | glycolithocholic acid | steroid |
| 247 | Bovis Calculus Artifactus | taurocholic acid | steroid |
| 248 | Bovis Calculus Artifactus | taurodeoxycholic acid | steroid |
| 249 | Bovis Calculus Artifactus | taurochenodeoxycholic acid | steroid |
| 252 | Bovis Calculus Artifactus | taurolithocholic acid | steroid |
| 253 | Bovis Calculus Artifactus | tauroursodeoxycholic acid | steroid |
| 255 | Bovis Calculus Artifactus | taurine | other |
| 256 | Bovis Calculus Artifactus | bilirubin | other |
| 257 | Bovis Calculus Artifactus | 7β-hydroxycholesterol | steroid |
| 258 | Bovis Calculus Artifactus | 25-hydroxycholesterol | steroid |

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|---|---|---|---|
| 259 | Bovis Calculus Artifactus | 5,6α-epoxycholesterol | steroid |
| 260 | Bovis Calculus Artifactus | 5,6β-epoxycholesterol | steroid |
| 261 | Bovis Calculus Artifactus | cholestane-3β,5α,6β-triol | steroid |
| 234 | Bovis Calculus Sativus | cholic acid | steroid |
| 235 | Bovis Calculus Sativus | deoxycholic acid | steroid |
| 236 | Bovis Calculus Sativus | chenodeoxycholic acid | steroid |
| 237 | Bovis Calculus Sativus | hyodeoxycholic acid | steroid |
| 238 | Bovis Calculus Sativus | ursodeoxycholic acid | steroid |
| 239 | Bovis Calculus Sativus | lithocholic acid | steroid |
| 240 | Bovis Calculus Sativus | 3α,12α-dihydroxy-7-oxo-5β-cholanic acid | steroid |
| 241 | Bovis Calculus Sativus | glycocholic acid | steroid |
| 247 | Bovis Calculus Sativus | taurocholic acid | steroid |
| 256 | Bovis Calculus Sativus | bilirubin | other |
| 234 | Bovis Fel | cholic acid | steroid |
| 235 | Bovis Fel | deoxycholic acid | steroid |
| 236 | Bovis Fel | chenodeoxycholic acid | steroid |
| 238 | Bovis Fel | ursodeoxycholic acid | steroid |
| 241 | Bovis Fel | glycocholic acid | steroid |
| 242 | Bovis Fel | glycodeoxycholic acid | steroid |
| 243 | Bovis Fel | glycochenodeoxycholic acid | steroid |
| 245 | Bovis Fel | glycohyodeoxycholic acid | steroid |
| 247 | Bovis Fel | taurocholic acid | steroid |
| 248 | Bovis Fel | taurodeoxycholic acid | steroid |
| 249 | Bovis Fel | taurochenodeoxycholic acid | steroid |

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| 251 | Bovis Fel | taurohyodeoxycholic acid | steroid |
| 252 | Bovis Fel | taurolithocholic acid | steroid |
| 253 | Bovis Fel | tauroursodeoxycholic acid | steroid |
| 262 | Bovis Fel | phosphatidylcholine | lipid |
| 234 | Ursi Fel | cholic acid | steroid |
| 236 | Ursi Fel | chenodeoxycholic acid | steroid |
| 238 | Ursi Fel | ursodeoxycholic acid | steroid |
| 239 | Ursi Fel | lithocholic acid | steroid |
| 242 | Ursi Fel | glycodeoxycholic acid | steroid |
| 243 | Ursi Fel | glycochenodeoxycholic acid | steroid |
| 246 | Ursi Fel | glycolithocholic acid | steroid |
| 247 | Ursi Fel | taurocholic acid | steroid |
| 248 | Ursi Fel | taurodeoxycholic acid | steroid |
| 249 | Ursi Fel | taurochenodeoxycholic acid | steroid |
| 252 | Ursi Fel | taurolithocholic acid | steroid |
| 253 | Ursi Fel | tauroursodeoxycholic acid | steroid |
| 254 | Ursi Fel | 7-keto-taurochenodeoxycholic acid | steroid |
| 262 | Ursi Fel | phosphatidylcholine | lipid |
| 263 | Ursi Fel | phosphatidylethanolamine | lipid |
| 264 | Ursi Fel | phosphatidylinositol | lipid |
| 234 | Suis Fellis Pulvis | cholic acid | steroid |
| 235 | Suis Fellis Pulvis | deoxycholic acid | steroid |
| 236 | Suis Fellis Pulvis | chenodeoxycholic acid | steroid |
| 237 | Suis Fellis Pulvis | hyodeoxycholic acid | steroid |

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|---|---|---|---|
| 238 | Suis Fellis Pulvis | ursodeoxycholic acid | steroid |
| 241 | Suis Fellis Pulvis | glycocholic acid | steroid |
| 242 | Suis Fellis Pulvis | glycodeoxycholic acid | steroid |
| 243 | Suis Fellis Pulvis | glycochenodeoxycholic acid | steroid |
| 244 | Suis Fellis Pulvis | glycohyocholic acid | steroid |
| 245 | Suis Fellis Pulvis | glycohyodeoxycholic acid | steroid |
| 246 | Suis Fellis Pulvis | glycolithocholic acid | steroid |
| 247 | Suis Fellis Pulvis | taurocholic acid | steroid |
| 249 | Suis Fellis Pulvis | taurochenodeoxycholic acid | steroid |
| 250 | Suis Fellis Pulvis | taurohyocholic acid | steroid |
| 251 | Suis Fellis Pulvis | taurohyodeoxycholic acid | steroid |
| 252 | Suis Fellis Pulvis | taurolithocholic acid | steroid |
| 239 | Serpentis Fel | lithocholic acid | steroid |
| 242 | Serpentis Fel | glycodeoxycholic acid | steroid |
| 247 | Serpentis Fel | taurocholic acid | steroid |
| 248 | Serpentis Fel | taurodeoxycholic acid | steroid |
| 249 | Serpentis Fel | taurochenodeoxycholic acid | steroid |
| 119 | Arisaema cum Bile | gallic acid | phenolic |
| 174 | Arisaema cum Bile | chlorogenic acid | phenolic |
| 173 | Arisaema cum Bile | syringic acid | phenolic |
| 109 | Arisaema cum Bile | ferulic acid | phenolic |
| 156 | Arisaema cum Bile | catechin | flavonoid |
| 132 | Arisaema cum Bile | quercetin | flavonoid |
| 265 | Arisaema cum Bile | sinapic acid | phenolic |

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|---|---|---|---|
| 266 | Arisaema cum Bile | neohesperidin | phenolic |
| 267 | Moschus | muscone | ketone |
| 268 | Moschus | normuscone | ketone |
| 269 | Moschus | muscopyridine | alkaloid |
| 1 | Moschus | resibufogenin (bufogenin) | steroid |
| 270 | Moschus | androsterone | steroid |
| 271 | Moschus | etiocholanolone | steroid |
| 272 | Moschus | 5α-androstane-3α,17β-diol | steroid |
| 273 | Moschus | 5β-androstane-3α,17β-diol | steroid |
| 274 | Moschus | epiandrosterone | steroid |
| 275 | Moschus | 3α-hydroxy-5β-androstan-17-one | steroid |
| 276 | Moschus | androsterone, trifluoroacetate | steroid |
| 277 | Moschus | dehydroandrosterone | steroid |
| 278 | Moschus | 3-ethyl-3-hydroxy-5α-androstan-17-one | steroid |
| 279 | Moschus | cholestan-3-ol | steroid |
| 280 | Moschus | testosterone | steroid |
| 281 | Moschus | epitestosterone | steroid |
| 282 | Moschus | androst-4-ene-3,17-dione | steroid |
| 283 | Moschus | cholesterol | steroid |
| 284 | Moschus | dehydroepiandrosterone | steroid |
| 285 | Moschus | prasterone-3-sulfate | steroid |
| 286 | Moschus | cholest-7-en-3β-ol | steroid |
| 287 | Moschus | 4α-methyl-5α-cholest-8(14)-en-3β-ol | steroid |
| 288 | Moschus | 1,1-diethoxy-ethane (acetal) | alkane |

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|---|---|---|---|
| 289 | Moschus | m-cresol | phenolic |
| 290 | Moschus | benzeneacetic acid | phenolic |
| 291 | Moschus | 6-methylheptane-1,6-diol | alcohol |
| 292 | Moschus | 1,2,6-hexanetriol | alcohol |
| 293 | Moschus | olealdehyde | aldehyde |
| 294 | Moschus | 8-n-hexylpentadecane | alkane |
| 295 | Moschus | 14-methyl-8-hexadecenal Z | aldehyde |
| 296 | Moschus | 2,6,10,15-tetramethylheptadecane | alkane |
| 297 | Moschus | 12-methyl-E,E-2,13-octadecadien-1-ol | alcohol |
| 298 | Moschus | 13-tetradecenal | aldehyde |
| 299 | Moschus | doconexent | fatty acid |
| 300 | Moschus | 2-tert-butyl-4,6-bis(3,5-di-tert-butyl-4-hydroxybenzyl)phenol | phenolic |
| 262 | Cervi Cornu Pantotrichum | phosphatidylcholine | lipid |
| 213 | Cervi Cornu Pantotrichum | ganglioside | lipid |
| 301 | Cervi Cornu Pantotrichum | chondroitin 4-sulfate | glycoprotein |
| 302 | Cervi Cornu Pantotrichum | chondroitin 6-sulfate | glycoprotein |
| 303 | Cervi Cornu Pantotrichum | dermatan sulfate | glycoprotein |
| 304 | Cervi Cornu Pantotrichum | heparan sulfate | glycoprotein |
| 305 | Cervi Cornu Pantotrichum | adenine | nucleobase |
| 306 | Cervi Cornu Pantotrichum | 2'-deoxyadenosine | nucleoside |
| 232 | Cervi Cornu Pantotrichum | adenosine | nucleoside |
| 307 | Cervi Cornu Pantotrichum | guanine | nucleobase |
| 308 | Cervi Cornu Pantotrichum | 2’-deoxyguanosine | nucleoside |

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|---|---|---|---|
| 309 | Cervi Cornu Pantotrichum | guanosine | nucleoside |
| 310 | Cervi Cornu Pantotrichum | thymine | nucleobase |
| 311 | Cervi Cornu Pantotrichum | thymidine | nucleoside |
| 312 | Cervi Cornu Pantotrichum | uracil | nucleobase |
| 313 | Cervi Cornu Pantotrichum | 2′-deoxyuridine | nucleoside |
| 314 | Cervi Cornu Pantotrichum | uridine | nucleoside |
| 315 | Cervi Cornu Pantotrichum | 2′-deoxycytidine | nucleoside |
| 316 | Cervi Cornu Pantotrichum | cytidine | nucleoside |
| 317 | Cervi Cornu Pantotrichum | xanthine | nucleobase |
| 318 | Cervi Cornu Pantotrichum | hypoxanthine | nucleobase |
| 319 | Cervi Cornu Pantotrichum | 2′-deoxyinosine | nucleoside |
| 320 | Cervi Cornu Pantotrichum | inosine | nucleoside |
| 321 | Bubali Cornu | WBH-1 | peptide |
| 322 | Bubali Cornu | WBH-2 | peptide |
| 323 | Bubali Cornu | WBH-3 | peptide |
| 324 | Hirudo | whitmanin | peptide |
| 325 | Hirudo | whitide | peptide |
| 326 | Hirudo | WP-30 | peptide |
| 327 | Hirudo | H1 | peptide |
| 328 | Hirudo | H2 | peptide |
| 329 | Hirudo | H3 | peptide |
| 330 | Hirudo | WA3-1 | peptide |
| 331 | Hirudo | HF2 | peptide |
| 181 | Hirudo | Gly | amino acid |

| | | | |
|---|---|---|---|
| 184 | Hirudo | Ala | amino acid |
| 186 | Hirudo | Val | amino acid |
| 191 | Hirudo | Leu | amino acid |
| 190 | Hirudo | Ile | amino acid |
| 187 | Hirudo | Met | amino acid |
| 188 | Hirudo | Trp | amino acid |
| 189 | Hirudo | Phe | amino acid |
| 178 | Hirudo | Ser | amino acid |
| 182 | Hirudo | Thr | amino acid |
| 185 | Hirudo | Tyr | amino acid |
| 192 | Hirudo | Lys | amino acid |
| 183 | Hirudo | Arg | amino acid |
| 180 | Hirudo | His | amino acid |
| 312 | Hirudo | uracil | nucleobase |
| 317 | Hirudo | xanthine | nucleobase |
| 318 | Hirudo | hypoxanthine | nucleobase |
| 332 | Bombina | bombesin | peptide |
| 333 | Bombina | DV-28 | peptide |
| 334 | Scolopendra | Ser-Gln-Leu | peptide |
| 176 | Scolopendra | Asp | amino acid |
| 183 | Scolopendra | Arg | amino acid |
| 184 | Scolopendra | Ala | amino acid |
| 191 | Scolopendra | Leu | amino acid |
| 192 | Scolopendra | Lys | amino acid |

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|---|---|---|---|
| 335 | Eupolyphaga | Es-termicin | peptide |
| 336 | Tabanus | tabanus anticoagulant protein | protein |
| 337 | Tabanus | palmitoleic acid | fatty acid |
| 338 | Tabanus | palmitic acid | fatty acid |
| 339 | Tabanus | linoleic acid | fatty acid |
| 340 | Tabanus | oleic acid | fatty acid |
| 341 | Tabanus | stearic acid | fatty acid |
| 342 | Mylabris | cantharidin | terpenoid |
| 343 | Scorpio | BmK I1 | peptide |
| 344 | Scorpio | BmK I4 | peptide |
| 345 | Scorpio | BmK I6 | peptide |
| 346 | Scorpio | BmK AngP1 | peptide |
| 347 | Scorpio | BmK dITAP3 | peptide |
| 348 | Scorpio | BmK ANEP | peptide |
| 349 | Scorpio | BmK AngM1 | peptide |
| 350 | Scorpio | BmK AS | peptide |
| 351 | Scorpio | BmK AS-1 | peptide |
| 352 | Scorpio | BmK AGP-SYPU1 | peptide |
| 353 | Scorpio | BmK AGP-SYPU2 | peptide |
| 354 | Scorpio | BmK AGAP | peptide |
| 355 | Scorpio | BmK AGAP-SYPU2 | peptide |
| 356 | Scorpio | BmK CT | peptide |
| 357 | Scorpio | BmK CT-13 | peptide |
| 358 | Scorpio | Asx | amino acid |

| | | | |
|---|---|---|---|
| 359 | Scorpio | Glx | amino acid |
| 178 | Scorpio | Ser | amino acid |
| 180 | Scorpio | His | amino acid |
| 181 | Scorpio | Gly | amino acid |
| 182 | Scorpio | Thr | amino acid |
| 183 | Scorpio | Arg | amino acid |
| 184 | Scorpio | Ala | amino acid |
| 185 | Scorpio | Tyr | amino acid |
| 360 | Scorpio | Cys | amino acid |
| 186 | Scorpio | Val | amino acid |
| 187 | Scorpio | Met | amino acid |
| 189 | Scorpio | Phe | amino acid |
| 190 | Scorpio | Ile | amino acid |
| 191 | Scorpio | Leu | amino acid |
| 192 | Scorpio | Lys | amino acid |
| 193 | Scorpio | Pro | amino acid |
| 361 | Scorpio | 3β-acetoxyl,2,14,22-trihydroxy,19-hydroxymethyl,9α,5β,14β-card-20(22)enolide | steroid |
| 362 | Scorpio | 1,2,3,4-tetrahydro-6-hydroxy1-5-pyrimidinecarbox-aldehyde | alkaloid |
| 363 | Holotrichia | prophenoloxidase | protein |
| 340 | Holotrichia | oleic acid | fatty acid |
| 338 | Holotrichia | palmitic acid | fatty acid |
| 337 | Holotrichia | palmitoleic acid | fatty acid |
| 364 | Pheretima | lumbricin-PG | peptide |

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|---|---|---|---|
| 318 | Pheretima | hypoxanthine | nucleobase |
| 340 | Pheretima | oleic acid | fatty acid |
| 339 | Pheretima | linoleic acid | fatty acid |
| 365 | Pheretima | arachidonic acid | fatty acid |
| 366 | Pheretima | eicosatrienoic acid | fatty acid |
| 367 | Ranae Oviductus | cholesteryl palmitate | ester |
| 368 | Ranae Oviductus | cholest-5-en-3β,7β-diol | steroid |
| 369 | Ranae Oviductus | 3β-hydroxy-cholest-5-en-7-one | steroid |
| 370 | Syngnathus | solenin | protein |
| 318 | Syngnathus | hypoxanthine | nucleobase |
| 371 | Hippocampus | HG-11 | glycoprotein |
| 372 | Hippocampus | HG-21 | glycoprotein |
| 373 | Hippocampus | lipid | lipid |
| 318 | Hippocampus | hypoxanthine | nucleobase |
| 317 | Hippocampus | xanthine | nucleobase |
| 374 | Bombyx Batryticatus | ergost-6,22-dien-3β,5α,8α-triol | steroid |
| 375 | Bombyx Batryticatus | β-sitosterol | steroid |
| 376 | Bombyx Batryticatus | daucosterol | steroid |
| 377 | Bombyx Batryticatus | meso-erythritol | saccharide |
| 378 | Bombyx Batryticatus | D-mannitol | saccharide |
| 338 | Bombyx Batryticatus | palmitic acid | fatty acid |
| 312 | Bombyx Batryticatus | uracil | nucleobase |
| 379 | Bombycis Faeces | (3S,5R,8R)-3,5-dihydroxymegastigma-6,7-dien-9-one | terpenoid |
| 380 | Bombycis Faeces | (S)-dehydrovomifoliol | terpenoid |

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|---|---|---|---|
| 381 | Bombycis Faeces | (6R,7E,9R)-9-hydroxy-4,7-megastigmadien-3-one | terpenoid |
| 382 | Bombycis Faeces | (3S,5R,6S,7E)-3,5,6-trihydroxy-7-megastigmen-9-one | terpenoid |
| 383 | Bombycis Faeces | (6R,9R)-9-hydroxy-4-megastigmen-3-one | terpenoid |
| 384 | Bombycis Faeces | alangionoside L | terpenoid |
| 385 | Bombycis Faeces | (6R,9R)-3-oxo-α-ionol-β-D-glucopyranoside | terpenoid |
| 386 | Bombycis Faeces | (6R,9S)-3-oxo-α-ionol-β-D-glucopyranoside | terpenoid |
| 387 | Bombycis Faeces | byzantionoside B | terpenoid |
| 388 | Bombycis Faeces | blumenol C glucoside | terpenoid |
| 389 | Bombycis Faeces | lutein | terpenoid |
| 390 | Bombycis Faeces | 1-deoxynojirimycin | alkaloid |
| 391 | Bombycis Faeces | fagomine | alkaloid |
| 392 | Bombycis Faeces | 3-epifagomine | alkaloid |
| 393 | Bombycis Faeces | betaine | alkaloid |
| 394 | Bombycis Faeces | pipecolic acid | other |
| 184 | Bombycis Faeces | Ala | amino acid |
| 359 | Bombycis Faeces | Glx | amino acid |
| 189 | Bombycis Faeces | Phe | amino acid |
| 191 | Bombycis Faeces | Leu | amino acid |
| 190 | Bombycis Faeces | Ile | amino acid |
| 395 | Vespae Nidus | fengfangin A | terpenoid |
| 396 | Vespae Nidus | tutin | terpenoid |
| 397 | Vespae Nidus | alnusone | diarylheptanoid |
| 398 | Vespae Nidus | centrolobol | diarylheptanoid |
| 399 | Vespae Nidus | muricarpone B | diarylheptanoid |

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|---|---|---|---|
| 400 | Vespae Nidus | 1-(3,4-dihydroxyphenyl)-7-(4-hydroxyphenyl)heptan-3-one | diarylheptanoid |
| 401 | Vespae Nidus | (3S)-1-(3,4-dihydroxyphenyl)-7-(4-hydroxyphenyl)heptan-3-ol | diarylheptanoid |
| 402 | Vespae Nidus | (3S)-1-(4-hydroxyphenyl)-7-(3,4-dihydroxyphenyl)heptan-3-ol | diarylheptanoid |
| 403 | Mantidis Oötheca | MEF | protein |
| 404 | Mantidis Oötheca | MEF-2 | protein |
| 405 | Mantidis Oötheca | MEF-3 | protein |
| 406 | Haliotidis Concha | perlucin | protein |
| 407 | Haliotidis Concha | perlustrin | protein |
| 408 | Haliotidis Concha | aquamarine blue pigment | other |
| 409 | Arcae Concha | A-Bg1 | peptide |
| 410 | Arcae Concha | A-Bh | peptide |
| 411 | Margaritifera Concha | water soluble protein | protein |
| 412 | Margaritifera Concha | acid soluble protein | protein |
| 413 | Margaritifera Concha | acid insoluble protein | protein |
| 414 | Margaritifera Concha | conchiolin protein | protein |
| 411 | Margarita | water soluble protein | protein |
| 412 | Margarita | acid soluble protein | protein |
| 413 | Margarita | acid insoluble protein | protein |
| 414 | Margarita | conchiolin protein | protein |
| 415 | Fossilia Ossis Mastodi | calcium carbonate | inorganic element |
| 416 | Fossilia Ossis Mastodi | hydroxyapatite | inorganic element |
| 417 | Fossilia Ossis Mastodi | Al | inorganic element |

| | | | |
|---|---|---|---|
| 418 | Fossilia Ossis Mastodi | Ba | inorganic element |
| 419 | Fossilia Ossis Mastodi | Bi | inorganic element |
| 420 | Fossilia Ossis Mastodi | Ca | inorganic element |
| 421 | Fossilia Ossis Mastodi | Ge | inorganic element |
| 422 | Fossilia Ossis Mastodi | I | inorganic element |
| 423 | Fossilia Ossis Mastodi | Ir | inorganic element |
| 424 | Fossilia Ossis Mastodi | K | inorganic element |
| 425 | Fossilia Ossis Mastodi | Mn | inorganic element |
| 426 | Fossilia Ossis Mastodi | Mo | inorganic element |
| 427 | Fossilia Ossis Mastodi | Na | inorganic element |
| 428 | Fossilia Ossis Mastodi | Ni | inorganic element |
| 429 | Fossilia Ossis Mastodi | Si | inorganic element |
| 430 | Fossilia Ossis Mastodi | V | inorganic element |
| 431 | Fossilia Ossis Mastodi | Zn | inorganic element |
| 432 | Fossilia Ossis Mastodi | Zr | inorganic element |

# 부록 2. 약어 리스트

BmK: *Buthus martensii* Karsch
CA: cholic acid
CCC: countercurrent chromatography
CCP: Cervi Cornu Pantotrichum
CDCA: chenodeoxycholic acid
CEC: capillary electro chromatography
CMC: cell membrane chromatography
DCA: deoxycholic acid
FOM: Fossilia Ossis Mastodi
FPLC: fast protein liquid chromatography
GC: gas chromatography
GCA: glycocholic acid
GCDCA: glycochenodeoxycholic acid
GDCA: glycodeoxycholic acid
GHCA: glycohyocholic acid
GHDCA: glycohyodeoxycholic acid
GLC: gas liquid chromatography
GLCA: glycolithocholic acid
GPC: gel permeation chromatography
HDCA: hyodeoxycholic acid
HPLC: high performance liquid chromatography
IMAC: immobilized metal affinity chromatography
LCA: lithocholic acid
MEEKC: microemulsion electrokinetic chromatography
MEF: mantis-egg fibrolase
MEKC: micellar electrokinetic capillary chromatography
MS: mass spectrometry
NPLC: normal phase liquid chromatography
PGC: pyrolysis gas chromatography
PMID: PubMed identifier
RPC: reversed-phase chromatography
RPLC: reversed phase liquid chromatography
RSLC: rapid separation liquid chromatography
SEC: size exclusion chromatography
SFC: capillary supercritical fluid chromatography
SMBC: simulated moving bed chromatography
TCA: taurocholic acid
TCDCA: taurochenodeoxycholic acid
TCM: traditional Chinese medicine
TCMID: Traditional Chinese Medicine Integrated Database

TCMSP: Traditional Chinese Medicine Systems Pharmacology
TDCA: taurodeoxycholic acid
THCA: taurohyocholic acid
THDCA: taurohyodeoxycholic acid
TLC: thin layer chromatography
TLCA: taurolithocholic acid
TMBC: true moving bed chromatography
TM-MC: database of medicinal materials and chemical compounds in Northeast Asian traditional medicine
TUDCA: tauroursodeoxycholic acid
UDCA: ursodeoxycholic acid
UFLC: ultra fast liquid chromatography
UPLC: ultra performance liquid chromatography.

# 부록 3. English version

# 1. Introduction

For a long time, traditional medicine in northeast Asia, including traditional Chinese medicine (TCM), has used diverse medicinal materials that can be obtained from nature. While most of these medicinal materials are botanical drugs or herbal drugs that use the flowers, leaves, branches, or roots of plants, non-botanical medicinal materials including animals, seashells, and minerals have been used as well. Modern medicine has conducted much research using science and technology to obtain evidence regarding whether such medicinal materials mentioned in traditional literature actually exhibit significant efficacy. With the considerable accumulation of research on evidence regarding the efficacy of such medicinal materials, reviews of the phytochemistry or pharmacology of medicinal materials have become more prevalent in recent years. However, such studies mainly deal with botanical medicinal materials, and research on non-botanical medicinal materials is comparatively rare.

In addition, databases that systematically collect the chemical constituents of diverse medicinal materials in traditional medicine are being constructed. In the field of TCM, several medicinal material databases have been constructed, such as Traditional Chinese Medicine Systems Pharmacology (TCMSP) [1], Traditional Chinese Medicine Integrated Database (TCMID) [2], and TCM@Taiwan [3]. These databases provide not only information on medicinal materials and their constituents, but also relevant formulae, targets, drugs, and diseases. In addition to the TCM database, many other databases are available in the global field of traditional medicine. ConMedNP [4] is a database of natural products derived from plants that grow naturally in Africa. NuBBE [5] contains information on medicinal plants in Brazil. Further, NPACT [6] and BioPhytMol [7] are databases for anti-cancer natural products and anti-mycobacterial natural products, respectively. Some databases do not provide the chemical constituents of non-botanical medicinal materials, and even databases providing information on these constituents do not hold much information. In contrast, TCMID and TCM@Taiwan provide relatively more information about non-botanical medicinal materials but do not contain up-to-date research results because the information provided is from published books.

Recently, TM-MC database was established by extracting information from research articles published in PubMed about the chemical constituents of the botanical medicinal materials listed in the pharmacopoeias of Korea, China, and Japan in Northeast Asia [8]. While the TM-MC database provides up-to-date information on the chemical constituents of the botanical medicinal materials extracted from PubMed, it does not provide information on the chemical constituents of non-botanical medicinal materials. Therefore, the purpose of this study is to construct up-to-date information from PubMed research articles about the chemical constituents of non-botanical medicinal materials and to add the extracted information to the TM-MC database. The information on the chemical constituents of non-botanical medicinal materials established in this study is currently available in the TM-MC database (http://informatics.kiom.re.kr/compound).

# 2. Methods

Information on the chemical constituents of the medicinal materials was extracted from PubMed research articles. With regard to the PubMed articles, those up to the 28 millionth PubMed identifier (PMID) were downloaded using the Entrez programming utility (http://www.ncbi.nlm.nih.gov/books/NBK25500), and the titles and abstracts were extracted from the XML files. For the names of medicinal materials used for the searches, the Latin names, common names, and scientific (binomial) names of non-botanical medicinal materials from among the medicinal materials listed in the Korean, Chinese, and Japanese pharmacopoeias were used to obtain objectively proven names of medicinal materials. This study indexed the articles with Apache Lucene [9] to search for medicinal materials regardless of both the affixes in the nouns and the order of the words in the names of the medicinal materials. The names of the medicinal materials included in the index were also used to find 232,692 articles. Among these articles, 11,640 articles containing analyses of medicinal materials by chromatography were selected by filtering the searched articles using the following key words: “chromatograph,” “CCC,” “CEC,” “CMC,” “FPLC,” “GC/MS,” “GC-MS,” “GLC,” “GPC,” “HPLC,” “IMAC,” “LC/MS,” “LC-MS,” “MEEKC,” “MEKC,” “NPLC,” “PGC,” “RPC,” “RPLC,” “RSLC,” “SEC,” “SFC,” “SMBC,” “TLC,” “TMBC,” “UFLC,” and “UPLC.” The full-text of the research articles finally selected through the aforementioned search and filtering process was then manually reviewed to extract the information on the chemical constituents of non-botanical medicinal materials.

# 3. Chemical constituents of non-botanical medicinal materials

Information on 432 chemical constituents from 36 non-botanical medicinal materials was extracted from 129 research articles. As shown in Table 1, the non-botanical medicinal materials from which the greatest amount of information was extracted were Bufonis Venenum (Toad venom), Propolis, and Stichopus (Sea cucumber). With regard to the classes of the constituents, which were classified after removing redundant constituents, the classes that included the largest number of compounds were steroids, flavonoids, and peptides, as shown in Table 2. The list of medicinal materials and compounds is given in the Supplementary Material.

The information about the constituents of each medicinal material is described in each of the following sections. The information of one medicinal material is generally described in each section, but the medicinal materials from animal bile are described together in one section because the compounds included in the medicinal materials are similar. Margaritifera Concha and Pearl were also described in the same section because they are one species that include the same extracted constituents. The medicinal materials were named by using the Latin names provided in the Chinese pharmacopoeia.

When available, a Common name was also mentioned. The scientific name and the family name were also included in each section.

### 3.1 Bufonis Venenum

Bufonis Venenum (known as Toad Venom) is the dried white secretion from the auricular gland of toads (*Bufo bufo gargarizans* Cantor or *Bufo melanostictus* Schneider from the family Bufonidae). The major active components of Bufonis Venenum are bufadienolides, which are a type of C-24 steroid with a α-2-pyrone ring at the C-17 position. Various bufadienolides have been identified from Bufonis Venenum [10-17], but the contents of individual bufadienolides contained in Bufonis Venenum vary significantly. In particular, resibufogenin, cinobufagin, bufotalin, and bufalin are known to account for more than 80% of the total bufadienolides [10]. The bufadienolides are divided into a 14,15-epoxy group and a 14-hydroxy group, as shown in Figure 2-4.

In addition to bufadienolides, serotonin was found in Bufonis Venenum in recent studies [16, 17]. In particular, the content of serotonin in a water extract of Bufonis Venenum was found to be over 20 times more than that of bufadienolides [16]. Figure 5 shows the chemical structures of serotonin and N-methylserotonin.

### 3.2 Propolis

Propolis is a natural resin substance that honeybees (*Apis mellifera* L. from the family Apidae) produce from the buds and bark of plants. Propolis, which has been used as a medicinal material from ancient times, includes phenolics, flavonoids, and glycerol esters. The chemical composition and bioactivity of Propolis are affected by the specific flora of the region from which it is collected. For this reason, the chemical constituents of Propolis produced only by *A. mellifera* in China, Korea, and Japan were investigated.

Phenolics contain phenolic acids (gallic acid and cinnamic acid derivatives) and stilbenoid (resveratrol). Propolis also includes phenylalkyl acids (cinnamic acid and cinnamylidene acetic acid). Cinnamic acid derivatives include a hydroxy group or a methoxy group linked at the C-3 and C-4 positions of the phenyl group as well as an ester linkage. Among these esters, caffeic acid phenethyl ester (CAPE) is one of the bioactive active materials in Propolis. Figure 6 shows the chemical structures of the phenolics and phenylalkyl acids in Propolis.

The flavonoids contained in Propolis are classified as anthocyanins, flavanones, flavans, and isoflavonoids. Figure 7 shows the chemical structures of anthocyanins. Anthocyanins are classified into two groups: flavones and flavonols. Flavonols have a hydroxyl group substituted at the C-3 position (R1) of 4H-chromene. Baicalin is a glucuronide of baicalein, while rutin, also called quercetin-3-O-rutinoside, is a glycoside formed by linking quercetin and disaccharide rutinose.

Figure 8 presents the chemical structure of the flavanones identified from Propolis. The flavanones in Propolis include pinocembrin, pinobanksin, and their ethers, as well as naringenin and hesperidin.

The flavans included in Propolis were found to be catechin and epicatechin belonging to the flavanol group (flavan-3-ol). Catechin, which has two chiral centers at the C-2 and C-3 positions of 4H-chromene, has four diastereoisomers ((2R,3S), (2S,3R), (2R,3R), and (2S,3S)), as shown in Figure 9. Genistein in the isoflavonoid group was also identified from Propolis.

In addition, nicotinic acid and glycerol esters, of which the structures are shown in Figure 10, were also isolated from Propolis.

## 3.3 Mel

Mel (known as Honey) is a sugary food substance collected by honeybees (*Apis mellifera* L. or *Apis cerana* Fabricus from the family Apidae) from plant nectar and honeydew. The main constituents of Mel are saccharides, including monosaccharides (glucose and fructose), disaccharides, and oligosaccharides [45]. Mel also contains phenolics, flavonoids, amino acids, enzymes, minerals, and vitamins [36, 37]. As in the case of Propolis, this survey included only chromatography studies of Mel produced by *A. mellifera* and *A. cerana* in China, Korea, and Japan. However, most of the studies about Mel found in PubMed were about European or Australian honey. In some studies [36, 37], nine phenolics and ten flavonoids were isolated from Chinese honey. Among them, the five phenolics of caffeic acid, ferulic acid, p-coumaric acid, caffeic acid phenethyl ester (CAPE), and gallic acid as well as the nine flavonoids of chrysin, apigenin, galangin, quercetin, rutin, morin, myricetin, pinocembrin, and naringenin were also identified from Propolis. Figure 11 shows four phenolics and one flavonoid which were isolated only from Mel.

In addition to phenolics and flavonoids, the contents of amino acids in Chinese honey collected from four botanical origins (linden, acacia, vitex, and rape) were compared [46], in which eighteen free amino acids of Asp, Glu, Ser, Gln, His, Gly, Thr, Arg, Ala, Tyr, Val, Met, Trp, Phe, Ile, Leu, Lys, and Pro were quantified.

## 3.4 Stichopus

Stichopus (known as Sea cucumber) is an echinoderm from the family Stichopodidae. The Korean pharmacopoeia states that the body wall of *Apostichopus japonicus* Selenka (named after *Stichopus japonicus* Selenka) is used as a medicine. Stichopus has been used as a nutritive food in Asia for thousands of years. The body wall of sea cucumber includes various types of bioactive substances, such as triterpene glycoside [47-49], glycosaminoglycan [50-52], cerebroside [53, 54], ganglioside [55], and protein [56-58].

Triterpene glycoside is the most important secondary metabolite in Stichopus. Hundreds of triterpene glycosides have been found in various species of sea cucumbers belonging to the Stichopodidae family of the Aspidochirotida order and the Cucumariidae family of the Dendrochirotida order. 17 types of triterpene glycosides were isolated from *A. japonicus*, as shown in Figure 12. All triterpene glycosides have a holostane-type aglycone with a C18(20) lactone group and an either Δ7(8) or Δ9(11) double bond along with a sugar chain composed of up to six monosaccharide units linked to the C-3 position of the aglycone.

The glycosaminoglycans of Stichopus have a linear polysaccharide structure consisting of repeated disaccharide units of chondroitin sulfate. Chondroitin sulfate is composed of glucuronic acid (GlcA) and N-acetylgalactosamine (GalNAc) sulfated at both the C-4 and C-6 positions, and glycosidically linked with sulfated fucose branches at the C-3 position of GlcA or at the C-4 and/or C-6 positions of GlaNAc. This fucosylation of the chondroitin sulfate from different holothurian species varies in number of branches as well as in the degrees and patterns of sulfation. The fucosylated chondroitin sulfate of *A. japonicus* has six types of sulfated-substituting patterns at the fucose branches, as shown in Figure 13: [$R_1$, $R_2$, $R_3$] = [$SO_3H$, $SO_3H$, H], [$SO_3H$, H, H], [H, $SO_3H$, H], [$SO_3H$, $SO_3H$, $SO_3H$], [$SO_3H$, H, $SO_3H$], and [H, $SO_3H$, $SO_3H$] [51].

Cerebrosides and gangliosides are glycosphingolipids found in plants, mammals, and marine invertebrates. A cerebroside consists of a sphingoid base, a fatty acid, and a monosaccharide. The fatty acid is linked to the sphingoid base through an amino bond, while the monosaccharide, which is either glucose or galactose, is linked to the 1-hydroxyl moiety of the sphingoid base. Variations in the degree of the sphingoid base, the chain length of the fatty acid, and in the saturation and/or hydroxylation characteristics lead to extensive differences in cerebrosides. Table 3 shows the sphingoid bases and fatty acids found in Stichopus.

While monosaccharides are linked to cerebrosides, oligosaccharides are linked to the 1-hydroxyl moiety of gangliosides, and one or more sialic acids are linked to the oligosaccharide. Cong et al. [55] analyzed the gangliosides found in Stichopus.

The main nutrient included in the body wall of Stichopus is protein. Wu et al.[56] found a major yolk protein and actin, which are noncollagenous proteins, from the body wall of Stichopus. Xia et al. [57] undertook iTRAQ analysis, which is a means of proteomic analysis, to identify sixteen proteins (melanotransferrin; complement component3-2; arginine kinase; heat shock protein gp 96; heat shock protein 90; translation elongation factor; myosin heavy chain, striated muscle-like isoform3; spectrin alphachain; peroxiredoxin-6; proprotein convertase subtilisin/kexin type9; 60S ribosomal protein L32e; cathepsin L-associated protein; 40S ribosomal protein S3-like; aldehyde dehydrogenase,mitochondrial-like; neurobeachin-like; alpha-centractin-like). Husni et al. [58] isolated adenosine and ethyl-α-D-glucopyranoside, as shown in Figure 14, from the body wall of Stichopus and found that the protein acts as a tyrosinase inhibitor.

In addition, Lee et al. [59] analyzed 53 volatile organic compounds and 15 inorganic components from a dried sample of Stichopus. The identified volatile organic compounds include alkanes, alkenes, amines, amides, imides, acids, aldehydes, alcohols, esters, and ketones, but this study does not provide the structural formulae of the individual components.

## 3.5 Bovis Calculus, Bovis Calculus Artifactus, Bovis Calculus Sativus, Bovis Fel, Ursi Fel, Suis Fellis Pulvis, and Serpentis Fel

In traditional medicine, animal gallstones or gall, such as cow bezoar, cattle bile, bear bile, pig bile, and serpent bile, have long been used for medicinal preparations. The key bioactive compounds included in the medicinal materials are bile acids. Recently, studies have been conducted to analyze bile acids and their contents in individual medicinal materials.

Bovis Calculus (known as cow bezoar or natural Calculus Bovis), is the dried gallstone of *Bos taurus domesticus* Gmelin from the family Bovidae. Due to the limited sources and high price of Bovis Calculus, Bovis Calculus Artifactus (known as artificial Calculus Bovis) was developed. Bovis Calculus Artifactus is created by mixing cattle bile, cholic acid (CA), hyodeoxycholic acid (HDCA), taurine, bilirubin and cholesterol to mimic natural Calculus Bovis. Bovis Calculus Artifactus is much less expensive than Bovis Calculus but has similar efficacy. Bovis Calculus Sativus was also developed, but Bovis Calculus Artifactus generally much more common in the market. The following list shows the chemical constituents identified from Bovis Calculus, Bovis Calculus Artifactus, and Bovis Calculus Artifactus.

- Bovis Calculus: cholic acid, deoxycholic acid (DCA), chenodeoxycholic acid (CDCA), hyodeoxycholic acid, ursodeoxycholic acid (UDCA), taurocholic acid (=taurocholate sodium, TCA), glycocholic acid (GCA), glycodeoxycholic acid (GDCA), glycochenodeoxycholic acid (GCDCA), taurodeoxycholic acid (TDCA), taurochenodeoxycholic acid (TCDCA), bilirubin [60-66].

- Bovis Calculus Artifactus: CA, DCA, CDCA, HDCA, UDCA, TCA, lithocholic acid (LCA), GCA, GDCA, GCDCA, glycolithocholic acid (GLCA), TDCA, taurolithocholic acid (TLCA), TCDCA, TUDCA, bilirubin, taurine [60-64, 66-71]

- Bovis Calculus Sativus: CA, DCA, CDCA, HDCA, UDCA, TCA, GCA, LCA, bilirubin, 3α,12α-dihydroxy-7-oxo-5β-cholanic acid [60, 61, 63, 64]

Many studies have been conducted to analyze the bioactive compounds contained in Bovis Calculus, Bovis Calculus Artifactus, and Bovis Calculus Artifactus quantitatively for quality control purposes [60, 61, 63, 64]. However, these reports have presented different results regarding the compounds and their contents included in the three medicinal materials. Therefore, the chemical markers of the three medicinal materials are difficult to determine.

Bovis Fel is the dried gall bladder of cattle (*Bos taurus domesticus* Gmelin) or of buffalos (*Bubalus bubalis* Linne) belonging to the family Bovidae. Ursi Fel is the dried bile of bears (*Ursus arctos* Linne or *Selenaretos thibetanus* Cuvier from the family Ursidae). Serpentis Fel is the dried gall bladder of serpents (*Naja naja* Cantor or *Bungarus fasciatus* Schneider from the family Elapidae, or *Elaphe radiata* Schlegel, *Ptyas korros* Schlegel, or *Zaocys dhumnades* Cantor from the family Colubridae), and Suis Fellis Pulvis is the dried bile of pigs (*Sus scrofa* Linne, or *Sus scrofa domestica* Brisson from the family Suidae). The following list shows the chemical constituents identified from the individual medicinal materials.

- Bovis Fel: CA, DCA, CDCA, UDCA, TCA, GCA, GDCA, GCDCA, glycohyodeoxycholic acid (GHDCA), TDCA, TLCA, TCDCA, taurohyodeoxycholic acid (THDCA), tauroursodeoxycholic acid (TUDCA) [62, 63, 72, 73].
- Ursi Fel: CA, CDCA, UDCA, LCA, TCA, GDCA, GLCA, GCDCA, TDCA, TLCA, TCDCA, 7-keto-TCDCA, TUDCA [62, 66, 73].
- Suis Fellis Pulvis: CA, DCA, CDCA, HDCA, UDCA, GCA, GDCA, glycohyocholic acid (GHCA), GCDCA, GHDCA, GLCA, TCA, taurohyocholic acid (THCA), TLCA, TCDCA, THDCA [61-63, 72, 74, 75].
- Serpentis Fel: TCA, LCA, GDCA, TDCA, TCDCA [62]

Figure 15-16 shows the chemical structures of the bile acids, taurine, and bilirubin which are listed above. Bile acids are a group of steroids bearing a carboxyl group at the C-17 side chain, which represents the characteristic constituents of human and animal bile.

Animal galls also include various sterols. Figure 17 shows five oxysterols which were isolated from Bovis Calculus and Bovis Calculus Artifactus [76].

In addition to bile acids and sterols, phospholipids such as phosphatidylcholine, phosphatidylethanolamine, phosphatidylinositol were found from Bovis Fel and Ursi Fel [73, 77].

## 3.6 Arisaema cum Bile

Arisaema cum Bile, which has been extensively used in traditional medicine, is a medicinal material prepared by mixing Arisaematis Rhizoma (*Arisaema amurense* Maximowicz, *Arisaema erubescens* Schott, *Arisaema heterophyllum* Blume from the family Araceae) powder with cattle, sheep, or pig bile and fermenting the resulting mixture. However, since little research has been done on the pharmacology of the Arisaema cum Bile, the chemical constituents that have traditional efficacy are still unknown. The PubMed search resulted in a study where eight phenolics (gallic acid, chlorogenic acid, syringic acid, ferulic acid, sinapic acid, catechin, quercetin, and neohesperidin) were isolated [78]. The structural formulae of sinapic acid and neohesperidin are shown in Figure 18.

## 3.7 Moschus

Moschus (known as Musk) is the dried secretion of the musk gland of the male musk deer (*Moschus berezovskii* Flerove, *M. chrysogaster* Hodgson, *M. moschiferus* Linne, and *M. sifanicus* Przewalski from the family Moschidae). Moschus is not only an important material for global perfumery, but is also one of the most famous and precious medicinal materials in traditional medicine. Moschus includes muscone, steroids, lipids, and proteins [79-83]. In particular, muscone, which contributes to the odor of musk, is the most important chemical constituent when evaluating the quality. Muscone-like macrocyclic substances isolated from Moschus include normuscone and muscopyridine, as shown in Figure 19.

Steroids account for a large portion of the chemical constituents of Moschus. The steroids detected in Moschus include resibufogenin [83], one of the constituents of Bufonis Venenum, and those listed in Figure 20.

In addition to steroids, Li et al.[83] isolated the following alkanes, alcohols, aldehydes, and aliphatic esters from musk as shown in Figure 21.

### 3.8 Cervi Cornu Pantotrichum (CCP)

CCP (known as Deer antler) is a dried preparation of the unossified antler of *Cervus nippon* Temminck, *C. elaphus* Linne or *C. canadensis* Erxleben from the family Cervidae. The chemical constituents of CCP include phospholipids, gangliosides, glycoproteins, nucleosides, amino acids, proteins, and cholesterols [84-90].

Kim et al.[84] detected a mixture of phosphatidylcholines with various fatty acids, such as the C14:0, C16:0, C18:0, C18:1, C18:2, and C20:4 types. Jhon et al. [85] found the five types of gangliosides shown in Table 4.

Glycosaminoglycans are made of repeating units of disaccharides. The glycosaminoglycan of CCP contains chondroitin 4-sulfate [86], chondroitin 6-sulfate [86], dermatan sulfate [86], and heparan sulfate [87]. In addition, the 17 nucleosides and nucleobases shown in Figure 22 were found in CCP.

### 3.9 Bubali Cornu

Bubali Cornu (known as water buffalo horn) is the horn of *Bubalus bubalis* Linnaeus from the family Bovidae. The chemical constituents of Bubali Cornu include amino acids, peptides, and cholesterols. Recently, three active peptides (WBH-1, WBH-2, and WBH-3) were isolated from Bubali Cornu [91]. The amino acid sequences of WBH-1, WBH-2, and WBH-3 were identified as Gln-Tyr-Asp-Gln-Gly-Val (708 Da), Tyr-Glu-Asp-Cys-Thr-Asp-Cys-Gly-Asn (1018 Da), and Ala-Ala-Asp-Asn-Ala-Asn-Glu-Leu-Phe-Pro-Pro-Asn (1271 Da), respectively.

### 3.10 Hirudo

Hirudo is the dried whole body of the leech (*Hirudo nipponica* Whitman from the family Hirudinidae, or *Whitmania pigra* Whitman or *W. acranulata* Whitman from the family Haemopidae). The major bioactive compounds contained in Hirudo are nucleobases, amino acids, and peptides. In particular, numerous pharmacology studies about anticoagulant peptide of Hirudo have been done. Hirudin, which is isolated from the medicinal leech *Hirudo medicinalis*, is a representative anticoagulant, acting as a thrombin inhibitor [92, 93]. In addition to hirudin, various anticoagulant peptides, such as whitmanin(8608 Da) [92], whitide(1997.1 Da) [94], WP-30(3140.63 Da) [95], H1(14998 Da), H2(15988 Da), H3(15956 Da) [96], WA3-1(1422 Da) [97], were recently isolated from Hirudo. Among these peptides, the amino acid sequences of whitide, WP-30, and WA3-1 are GPAGPVGAPGGPGVRGLPGDRG, VISRTQSNVQAAWGQVGGHAADYSAVAIER, HDFLNNKLEYE, respectively. A high Fischer's ratio peptide, called HF2 (<874 Da), was also extracted from Hirudo [97].

In addition to the peptides, the 14 amino acids of Gly, Ala, Val, Leu, Ile, Met, Trp, Phe, Ser, Thr, Tyr, Lys, Arg, and His [98] as well as the nucleobases of uracil, xanthine [98], and hypoxanthine [93, 99] were isolated from Hirudo and quantified for a quality comparison.

### 3.11 Bombina

Bombina is the dried whole body of the oriental fire-bellied toad (*Bombina orientalis* Bouglenger from the family Bombinatoridae). Most studies of the chemical constituents of Bombina were conducted with regard to the peptides extracted from the skin. Bombesin (PubChem 16133800) is a 14-amino acid peptide (1619.9 Da) isolated from the skin of Bombina [100]. The amino acid sequence of bombesin is Pyr-Gln-Arg-Leu-Gly-Asn-Gln-Trp-Ala-Val-Gly-His-Leu-Met, where pyroglutamic acid is at the N-terminal and NH2 is at the C-terminal. Recently, a peptide termed DV-28 (3198.5 Da) was found in the secretion from the skin of Bombina [101]. The amino acid sequence of DV-28 is DMYEIKGFKSAHGRPRVCPPGEQCPIWV, with a disulfide bridge between Cys18 and Cys24 and an amidated C-terminal Val residue.

### 3.12 Scolopendra

Scolopendra is the dried whole body of centipedes (*Scolopendra subspinipes mutilans* L. Koch from the family Scolopendridae). A peptide (Ser-Gln-Leu) with antithrombotic activity was isolated from Scolopendra [102], and five amino acids, Asp, Arg, Ala, Leu, and Lys, were isolated and quantified [103].

### 3.13 Eupolyphaga

Eupolyphaga (known as Steleophaga) is the dried whole body of female cockroaches (*Eupolyphaga sinensis* Walker or *Steleophaga plancyi* (Boleny) from the family Corydiidae). An antimicrobial peptide called Es-termicin was isolated from Eupolyphaga [104]. The amino acid sequence of Es-termicin is ACDFQQCWVTCQRQYSINFISARCNGDSCVCTFRT, which is very similar to the sequence of termicin, known to inhibit filamentous fungi.

### 3.14 Tabanus

Tabanus is the dried whole body of the female adult *Tabanus mandarinus* Schiner or *T. bivittatus* Matsumura from the family Tabanidae. Tabanus anticoagulant protein (65k Da) with anticoagulant activity was isolated from Tabanus [105]. Ding et al. [106] extracted 21 fatty acids from Tabanus and showed that palmitoleic acid, palmitic acid, linoleic acid, oleic acid, and stearic acid are the main compounds among them.

### 3.15 Mylabris

Mylabris is the dried whole body of *Mylabris cichorii* Linne, *M. phalerata* Pallas or *Epicauta gorhami* Marseul from the family Meloidae. The Korean and Chinese pharmacopoeias state that the main constituent of Mylabris is cantharidin (PubChem 5944), as shown in Figure 23. The PubMed search provided a report comparing the cantharidin content in Mylabris before and after biotransformation [107].

### 3.16 Scorpio

Scorpio is the dried whole body of scorpions (*Buthus martensii* Karsch, BmK, from the family Buthidae). The bioactive constituents of Scorpio are concentrated in the venom produced from the gland of the scorpion. Scorpion venom includes analgesic peptides or antitumor peptides. The following analgesic peptides were isolated and characterized from Scorpio: BmK I1, BmK I4, BmK I6, BmK AngP1, BmK dITAP3, BmK ANEP, BmK AngM1, BmK AS, BmK AS-1, BmK AGP-SYPU1, BmK AGP-SYPU2, BmK AGAP, and BmK AGAP-SYPU2 [108-110]. The antitumor peptides isolated from Scorpio are BmK CT and BmK CT-13 [111], which have amino sequences similar to that of chlorotoxin, which is used as an antitumor drug. In addition, among the analgesic peptides, BmK AGAP and BmK AGAP-SYPU2 are bifunctional peptides with both analgesic activity and antitumor activity. In addition to the two types of bioactivity, two chemical constituents with antibacterial activity were isolated from Scorpio [112], as shown in Figure 24.

In addition, Lee et al. [113] detected the 17 amino acids of Asx, Glx, Ser, His, Gly, Thr, Arg, Ala, Tyr, Cys, Val, Met, Phe, Ile, Leu, Lys, and Pro from Scorpio.

### 3.17 Holotrichia

Holotrichia is the larvae of chafer (*Holotrichia diomphalia* Bates from the family Melolonthidae) or other similar insects. Prophenoloxidase participating in the defense reaction and wound healing of insects was extracted from the hemolymph of Holotrichia [114]. The oleic acid, palmitic acid, and palmitoleic acid contained in Holotrichia show anti-inflammatory and analgesic activities [115].

### 3.18 Pheretima

Pheretima is the dried whole body of earthworms (*Pericaeta communisma* Gate et Hatai, *Pheretima aspergillum* E. Perrier, *P. vulgaris* Chen, *P. guillelmi (*Michaelsen), or *P. pectinifera* Michaelsen from the family Megascolecidae, or *Allolobophora caliginosa* var. *trapezoides* Anton from the family Lumbricidae). Lumbricin-PG, an antimicrobial peptide, was purified from the skin of *P. guillelmi* (Michaelsen) [116]. Lumbricin-PG includes 59 amino acid residues and has a molecular weight of 6908.7 Da. These characteristics of Lumbricin-PG are similar to those of lumbricin, an antimicrobial peptide identified in *Lumbricus rubellus*. In addition to antimicrobial peptide, hypoxanthine [117] and the unsaturated fatty acids of oleic acid, linoleic acid, arachidonic acid, and eicosatrienoic acid [118] were isolated from *P. aspergillum.*

## 3.19 Ranae Oviductus

Ranae Oviductus is the dried oviducts of *Rana temporaria chensinensis* David from the family Ranidae. Figure 25 shows the cholesteryl esters [119] and steroids [120] which were extracted from Ranae Oviductus.

## 3.20 Syngnathus

Syngnathus is the dried whole body of pipefish (*Solenognathus hardwickii* (Gray), *Syngnathoides biaculeatus* (Bloch), or *Syngnathus acus* Linnaeus from the family Syngnathidae). Recently, solenin, a protein with translation-inhibiting activity, was isolated from pipefish [121]. This protein has a molecular weight of 18 kD and possesses the N-terminal sequence AHDAEVNEVKAQVAA. In addition, hypoxanthine, an antioxidant compound, was extracted from Syngnathus [122].

## 3.21 Hippocampus

Hippocampus is the dried whole body of seahorses (*Hippocampus coronatus* Temminck et Schlegel, *H. kelloggi* Jordan et Snyder, *H. histrix* Kaup, *H. kuda* Bleeker, *H. trimaculatus* Leach, or *H. japonicus* Kaup from the family Syngnathidae). The chemical constituents of Hippocampus include amino acids, peptides, glycoproteins, lipids, and steroids. Su et al. [123] extracted and purified two glycoproteins, HG-11 and HG-21, from *H. kuda* Bleeker, where the saccharide contents were 56.7975% and 39.479%, respectively, and the corresponding protein contents were 30.5475% and 51.747%. Chen et al. [124] isolated lipids with anti-inflammatory activity from *H. trimaculatus* Leach. The lipids include neutral lipids, glycolipids and phospholipids and exhibit various fatty acid compositions. In addition, Hippocampus contains hypoxanthine and xanthine [122, 125].

## 3.22 Bombyx Batryticatus

Bombyx Batryticatus is the dried dead bodies of silkworm larvae (*Bombyx mori* L. from the family Bombycoidea) infected by *Beauveria bassiana* (Bals.) Vuillant. The chemical constituents of Bombyx Batryticatus include sterols (ergost-6,22-dien-3β,5α,8α-triol, β-sitosterol, and daucosterol) and sugar alcohols (meso-erythritol and d-mannitol) as shown in Figure 26 as well as palmitic acid and uracil [126].

## 3.23 Bombycis Faeces

Bombycis Faeces is the dried droppings of silkworm larvae (*Bombyx mori* L. from the family Bombycoidea). Bombycis Faeces includes megastigmane sesquiterpenes, megastigmane glycosides, carotenoids, alkaloids, and amino acids [127-129]. The chemical structures of five megastigmane sesquiterpenes [127, 128] and five megastigmane sesquiterpene glycosides [127], lutein [127], and three alkaloids [129] isolated from Bombycis Faeces are shown in Figure 27.

In addition, amino acids (Ala, Glx, Phe, Leu, and Ile) as well as betaine, which is an amino acid derivative, and pipecolic acid, a metabolite of lysine, were detected in Bombycis Faeces [127]. Figure 28 shows the chemical structures of betaine and pipecolic acid.

## 3.24 Vespae Nidus

Vespae Nidus is the nest of *Polistes mandarinus* Saussure et Geer, *P. olivaceous* (DeGeer), *P. japonicus* Saussure, or *Parapolybia varia* Fabricius from the family Vespidae. Recently, two sesquiterpenoids and six diarylheptanoids, as shown in Figure 29, were isolated from Vespae Nidus [130].

## 3.25 Mantidis Oötheca

Mantidis Oötheca is the dried egg case of the mantis (*Tenodera angustipennis* Saussure, *T. sinensis* Saussure, *Statilia maculata* (Thunberg), or *Hierodula patellifera* (Serville) from the family Mantidae). Mantidis Oötheca contains a protease with fibrinolytic activity. A mantis-egg fibrolase (MEF) [131] with a molecular weight of 32.8k Da was extracted from Mantidis Oötheca. Similar fibrinolytic proteases, MEF-2 (32.9k Da) and MEF-3 (35.6k Da), were also purified from Mantidis Oötheca [132].

## 3.26 Haliotidis Concha

Haliotidis Concha is the shell of *Nardotis gigantea* (Gmelin), *Sulculus diversicolor supertexta* (Lischke), *Haliotis diversicolor* Reeve, *H. discus hannai* Ino, *H. ovina* Gmelin, *H. ruber* (Leach), *H. asinina* Linnaeus, or *H. laevigata* (Donovan) from the family Haliotidae. More than 90% of the chemical constituents of abalone shell are calcium carbonate and other organic or inorganic substances also included in the abalone shell. Recently, two proteins, perlucin (17k Da) and perlustrin (13k Da), were isolated from the shell of H. laevigata [133], and an aquamarine blue pigment identified as a polyenic compound was extracted from the shell of *H. discus hannai* Ino [134].

## 3.27 Arcae Concha

Arcae Concha is the shell of *Scapharca subcrenata* (Lischke), *S. broughtonii* Schrenck, *Tegillarca granosa* (Linne), *Arca subcrenata* Lischke, *A. granosa* Linnaeus, or *A. inflata* Reeve from the family Arcidae. The main constituent of the Arcae Concha is calcium carbonate. Recently, two antioxidant peptides, A-Bg1 and A-Bh, were isolated from the alcalase hydrolysate of *S. subcrenata* [135].

## 3.28 Margaritifera Concha and Margarita

Margaritifera Concha (known as mother of pearl or nacre) is the shell of *Hyriopsis cumingii* (Lea) or *Cristaria plicata* (Leach) from the family Unionidae, or *Pteria martensii* (Dunker) or *Pinctada fucata martensii* (Dunker) from the family Pteriidae, and Margarita (known as pearl) is a hard object produced by Margaritifera Concha. The main constituent of both Margaritifera Concha and Margarita is calcium carbonate, as in the cases of Haliotidis Concha and Arcae Concha. Water-soluble proteins, acid soluble proteins, acid insoluble proteins, and conchiolin proteins were isolated as organic compounds from both Margaritifera Concha and Margarita[136, 137].

### 3.29 Fossilia Ossis Mastodi (FOM)

FOM (known as Longgu) is the ossified bones of large mammals. FOM resources are limited and non-reproducible, but FOM has been used in traditional medicine for more than one thousand years. FOM includes aragonite type calcium carbonate and hydroxyapatite as the main constituents, as well as sixteen other elements (Al, Ba, Bi, Ca, Ge, I, Ir, K, Mn, Mo, Na, Ni, Si, V, Zn, and Zr) [138].

# 4. Conclusion

Most studies of the chemical constituents of medicinal materials used in traditional medicine have been conducted on botanical medicinal materials. Several databases provide information about many botanical medicinal materials. However, although many non-botanical medicinal materials, including animals, seashells, and minerals, have been frequently used for clinical purposes, there is much less available information on the chemical constituents of non-botanical medicinal materials compared to that on botanical medicinal materials. Therefore, it is necessary systematically to establish an information database about the chemical constituents of non-botanical medicinal materials. Generally, when a review of medicinal materials is conducted, various databases are used, including PubMed, Scopus, Web of Science, and Google Scholar. For a survey of TCM, Chinese databases established in the Chinese language are also used. However, much time is needed to review the entire set of literature about only a single medicinal material, and vast amounts of time are required to review many hundreds of non-botanical medicinal materials. Existing databases are generally used due to the time limits when studying medicinal materials, but some of the non-botanical medicinal materials are not included in the databases. Moreover, the databases are constructed based on published books and thus do not include up-to-date research information. In general, the chemical constituents of medicinal materials are dependent on the origin of the medicinal materials and the compound extraction methods. This dependence is greater with non-botanical medicinal materials than it is with botanical medicinal materials. However, the information included in published books is limited to the names of medicinal materials and compounds, while for detailed information, researchers must search the references of the books despite the fact that they are difficult to obtain in comparison with online databases.

Therefore, this study was conducted as an effort to establish a database of up-to-date information on the chemical constituents of non-botanical medicinal materials systematically by investigating their constituents from chromatography research articles available in PubMed, which is an online research article database. The amount of current information on the chemical constituents of individual medicinal materials is less in comparison to when all research article databases are searched, as only the PubMed database was searched here. However, the information on the chemical constituents of all the non-botanical medicinal materials was searched for in the PubMed database. In general, conventional review work has mainly been done on medicinal materials for which information has been well discovered thus far. This article presents a timely summary of the chemical constituents of all the non-botanical medicinal materials, including medicinal materials that are not well studied. Information on constituent compounds in this survey has already been published in other articles. Thus, this article does not introduce novel compounds but instead summarizes all compounds of non-botanical materials which can be found in PubMed literatures.

This study surveyed only chromatography articles, matching the method used during the construction of TM-MC. Chromatography is a general experimental method for separating mixtures. Most of the articles regarding the compounds of medicinal materials were found, but some articles may not have been included in the present study. Therefore, to increase the completeness of the databases, future studies should filter research articles using another screening method or should review all research articles about medicinal materials.

The information on the chemical constituents of the botanical medicinal materials included in the pharmacopoeias of Korea, China, and Japan from the PubMed database is already provided by TM-MC. However, because the names of compounds are used as the identifiers in TM-MC, the compound information is redundant. Currently, TM-MC is working on addressing this redundancy problem. As a separate work, this study was conducted using the chemical structure formulae of all of the chemical constituents as identifiers to remove redundancy. In addition, for the compounds included in the PubChem databases, the PubChem IDs were also provided so that the users can obtain more information.

# 참고 문헌

1. Ru J, Li P, Wang J, Zhou W, Li B, Huang C, Li P, Guo Z, Tao W, Yang Y *et al*: **TCMSP: a database of systems pharmacology for drug discovery from herbal medicines**. *J Cheminform* 2014, **6**:13.
2. Xue R, Fang Z, Zhang M, Yi Z, Wen C, Shi T: **TCMID: Traditional Chinese Medicine integrative database for herb molecular mechanism analysis**. *Nucleic Acids Res* 2013, **41**:D1089-1095.
3. Chen CY: **TCM Database@Taiwan: the world's largest traditional Chinese medicine database for drug screening in silico**. *PLoS One* 2011, **6**(1):e15939.
4. Ntie-Kang F, Onguene PA, Scharfe M, Owono LCO, Megnassan E, Mbaze LM, Sippl W, Efange SMN: **ConMedNP: a natural product library from Central African medicinal plants for drug discovery**. *Rsc Adv* 2014, **4**(1):409-419.
5. Valli M, dos Santos RN, Figueira LD, Nakajima CH, Castro-Gamboa I, Andricopulo AD, Bolzani VS: **Development of a natural products database from the biodiversity of Brazil**. *Journal of natural products* 2013, **76**(3):439-444.
6. Mangal M, Sagar P, Singh H, Raghava GP, Agarwal SM: **NPACT: Naturally Occurring Plant-based Anti-cancer Compound-Activity-Target database**. *Nucleic Acids Res* 2013, **41**:D1124-1129.
7. Sharma A, Dutta P, Sharma M, Rajput NK, Dodiya B, Georrge JJ, Kholia T, Bhardwaj A, Consortium O: **BioPhytMol: a drug discovery community resource on anti-mycobacterial phytomolecules and plant extracts**. *J Cheminformatics* 2014, **6**.
8. Kim SK, Nam S, Jang H, Kim A, Lee JJ: **TM-MC: a database of medicinal materials and chemical compounds in Northeast Asian traditional medicine**. *BMC complementary and alternative medicine* 2015, **15**:218.
9. McCandless M, Hatcher E, Gospodnetić O, Gospodnetić O: **Lucene in action**, 2nd edn. Greenwich: Manning; 2010.
10. Meng Q, Yau LF, Lu JG, Wu ZZ, Zhang BX, Wang JR, Jiang ZH: **Chemical profiling and cytotoxicity assay of bufadienolides in toad venom and toad skin**. *J Ethnopharmacol* 2016, **187**:74-82.
11. Zhou J, Gong Y, Ma HY, Wang HL, Qian DW, Wen HM, Liu R, Duan JA, Wu QN: **Effect of drying methods on the free and conjugated bufadienolide content in toad venom determined by ultra-performance liquid chromatography-triple quadrupole mass spectrometry coupled with a pattern recognition approach**. *J Pharmaceut Biomed* 2015, **114**:482-487.
12. Hu YM, Yu ZL, Yang ZJ, Zhu GY, Fong WF: **Comprehensive chemical analysis of Venenum Bufonis by using liquid chromatography/electrospray ionization tandem mass spectrometry**. *J Pharmaceut Biomed* 2011, **56**(2):210-220.
13. Gao HM, Zehl M, Leitner A, Wu XY, Wang ZM, Kopp B: **Comparison of toad venoms from different Bufo species by HPLC and LC-DAD-MS/MS**. *J Ethnopharmacol* 2010, **131**(2):368-376.
14. Qiu YK, Yan X, Fang MJ, Chen L, Wu Z, Zhao YF: **Two-dimensional countercurrent chromatography x high performance liquid chromatography for preparative isolation of toad venom**. *J Chromatogr A* 2014, **1331**:80-89.
15. Ye M, Guo H, Guo HZ, Han J, Guo D: **Simultaneous determination of cytotoxic bufadienolides in the Chinese medicine ChanSu by high-performance liquid chromatography coupled with photodiode array and mass spectrometry detections**. *J Chromatogr B* 2006, **838**(2):86-95.
16. Lee HJ, Koung FP, Kwon KR, Kang DI, Cohen L, Yang PY, Yoo HS: **Comparative Analysis of the Bufonis Venenum by Using TLC, HPLC, and LC-MS for Different Extraction Methods**. *J Pharmacopuncture* 2012, **15**(4):52-65.
17. Qu T, Gao HM, Chen LM, Wang ZM, Zhang QW, Cheng YY: **[Content of indole alkaloids and bufadienolides contained in toad medicines]**. *Zhongguo Zhong Yao Za Zhi* 2012, **37**(20):3086-3091.

18. Li JF, Fang H, Yan X, Chang FR, Wu Z, Wu YL, Qiu YK: **On-line comprehensive two-dimensional normal-phase liquid chromatographyxreversed-phase liquid chromatography for preparative isolation of toad venom**. *J Chromatogr A* 2016, **1456**:169-175.
19. Ma H, Niu H, Cao Q, Zhou J, Gong Y, Zhu Z, Lv X, Di L, Qian D, Wu Q *et al*: **Metabolomics method based on ultra high performance liquid chromatography with time-of-flight mass spectrometry to analyze toxins in fresh and dried toad venom**. *J Sep Sci* 2016, **39**(24):4681-4687.
20. Gao HM, Zehl M, Kaehlig H, Schneider P, Stuppner H, Banuls LMY, Kiss R, Kopp B: **Rapid Structural Identification of Cytotoxic Bufadienolide Sulfates in Toad Venom from Bufo melanosticus by LC-DAD-MSn and LC-SPE-NMR**. *Journal of natural products* 2010, **73**(4):603-608.
21. Lu Y, Wu C, Yuan Z: **Determination of hesperetin, cinnamic acid and nicotinic acid in propolis with micellar electrokinetic capillary chromatography**. *Fitoterapia* 2004, **75**(3-4):267-276.
22. Guo XL, Chen B, Luo LP, Zhang X, Dai XM, Gong SJ: **Chemical Compositions and Antioxidant Activities of Water Extracts of Chinese Propolis**. *J Agr Food Chem* 2011, **59**(23):12610-12616.
23. Zhang CP, Huang S, Wei WT, Ping S, Shen XG, Li YJ, Hu FL: **Development of High-Performance Liquid Chromatographic for Quality and Authenticity Control of Chinese Propolis**. *J Food Sci* 2014, **79**(7):C1315-C1322.
24. Ahn MR, Kumazawa S, Hamasaka T, Bang KS, Nakayama T: **Antioxidant activity and constituents of propolis collected in various areas of Korea**. *J Agr Food Chem* 2004, **52**(24):7286-7292.
25. Gomez-Caravaca AM, Gomez-Romero M, Arraez-Roman D, Segura-Carretero A, Fernandez-Gutierrez A: **Advances in the analysis of phenolic compounds in products derived from bees**. *J Pharmaceut Biomed* 2006, **41**(4):1220-1234.
26. Chen J, Long Y, Han M, Wang T, Chen Q, Wang R: **Water-soluble derivative of propolis mitigates scopolamine-induced learning and memory impairment in mice**. *Pharmacol Biochem Be* 2008, **90**(3):441-446.
27. Sha N, Huang HL, Zhang JQ, Chen GT, Tao SJ, Yang M, Li XN, Li P, Guo DA: **Simultaneous Quantification of Eight Major Bioactive Phenolic Compounds in Chinese Propolis by High-Performance Liquid Chromatography**. *Nat Prod Commun* 2009, **4**(6):813-818.
28. Shi HM, Yang HS, Zhang XW, Yu LL: **Identification and Quantification of Phytochemical Composition and Anti-inflammatory and Radical Scavenging Properties of Methanolic Extracts of Chinese Propolis**. *J Agr Food Chem* 2012, **60**(50):12403-12410.
29. Li AF, Xuan HZ, Sun AL, Liu RM, Cui JC: **Preparative separation of polyphenols from water-soluble fraction of Chinese propolis using macroporous absorptive resin coupled with preparative high performance liquid chromatography**. *J Chromatogr B* 2016, **1012**:42-49.
30. Xuan H, Wang Y, Li A, Fu C, Wang Y, Peng W: **Bioactive Components of Chinese Propolis Water Extract on Antitumor Activity and Quality Control**. *Evid Based Complement Alternat Med* 2016, **2016**:9641965.
31. Li Y, Zhao J, Xue X, Zhou J: **[Determination of twelve active compounds in propolis using ultra-performance liquid chromatography]**. *Se Pu* 2007, **25**(6):857-860.
32. Shi HM, Yang HS, Zhang XW, Sheng Y, Huang HQ, Yu LL: **Isolation and Characterization of Five Glycerol Esters from Wuhan Propolis and Their Potential Anti-Inflammatory Properties**. *J Agr Food Chem* 2012, **60**(40):10041-10047.
33. Wang K, Zhang JL, Ping S, Ma QX, Chen X, Xuan HZ, Shi JH, Zhang CP, Hu FL: **Anti-inflammatory effects of ethanol extracts of Chinese propolis and buds from poplar (Populus x canadensis)**. *J Ethnopharmacol* 2014, **155**(1):300-311.
34. Wang ZB, Sun R, Wang YP, Li N, Lei L, Yang X, Yu AM, Qiu FP, Zhang HQ: **Determination of phenolic acids and flavonoids in raw propolis by silica-supported ionic liquid-based matrix**

**solid phase dispersion extraction high performance liquid chromatography-diode array detection**. *J Chromatogr B* 2014, **969**:205-212.
35. Zhang JL, Cao XP, Ping S, Wang K, Shi JH, Zhang CP, Zheng HQ, Hu FL: **Comparisons of Ethanol Extracts of Chinese Propolis (Poplar Type) and Poplar Gums Based on the Antioxidant Activities and Molecular Mechanism**. *Evid-Based Compl Alt* 2015.
36. Zhang XH, Wu HL, Wang JY, Tu DZ, Kang C, Zhao J, Chen Y, Miu XX, Yu RQ: **Fast HPLC-DAD quantification of nine polyphenols in honey by using second-order calibration method based on trilinear decomposition algorithm**. *Food Chem* 2013, **138**(1):62-69.
37. Zhou JH, Yao LH, Li Y, Chen LZ, Wu LM, Zhao J: **Floral classification of honey using liquid chromatography-diode array detection-tandem mass spectrometry and chemometric analysis**. *Food Chem* 2014, **145**:941-949.
38. Jin UH, Chung TW, Kang SK, Suh SJ, Kim JK, Chung KH, Gu YH, Suzuki I, Kim CH: **Caffeic acid phenyl ester in propolis is a strong inhibitor of matrix metalloproteinase-9 and invasion inhibitor: Isolation and identification**. *Clinica Chimica Acta* 2005, **362**(1-2):57-64.
39. Zhou L, Guo J, Yu J: **[Flavonoids from Beijing propolis]**. *Zhongguo Zhong Yao Za Zhi* 1999, **24**(3):162-164, 191.
40. Wang K, Ping S, Huang S, Hu L, Xuan H, Zhang C, Hu F: **Molecular mechanisms underlying the in vitro anti-inflammatory effects of a flavonoid-rich ethanol extract from chinese propolis (poplar type)**. *Evid Based Complement Alternat Med* 2013, **2013**:127672.
41. Nie P, Xia Z, Sun DW, He Y: **Application of visible and near infrared spectroscopy for rapid analysis of chrysin and galangin in Chinese propolis**. *Sensors (Basel)* 2013, **13**(8):10539-10549.
42. Zhou J, Li Y, Zhao J, Xue X, Wu L, Chen F: **Geographical traceability of propolis by high-performance liquid-chromatography fingerprints**. *Food Chem* 2008, **108**(2):749-759.
43. Sun LP, Xu X, Hwang HH, Wang X, Su KY, Chen YL: **Dichloromethane extracts of propolis protect cell from oxygen-glucose deprivation-induced oxidative stress via reducing apoptosis**. *Food Nutr Res* 2016, **60**:30081.
44. Wang XP, Lin L, Chen ZL, Ma YY, Pan JG: **[Quantitative analysis of galangin from propolis in different areas by HPLC]**. *Zhong Yao Cai* 2007, **30**(5):560-562.
45. Ruiz-Matute AI, Sanz ML, Martinez-Castro I: **Use of gas chromatography-mass spectrometry for identification of a new disaccharide in honey**. *J Chromatogr A* 2007, **1157**(1-2):480-483.
46. Chen H, Jin L, Chang Q, Peng T, Hu X, Fan C, Pang G, Lu M, Wang W: **Discrimination of botanical origins for Chinese honey according to free amino acids content by high-performance liquid chromatography with fluorescence detection with chemometric approaches**. *J Sci Food Agric* 2016.
47. Dong P, Xue CH, Yu LF, Xu J, Chen SG: **Determination of triterpene glycosides in sea cucumber (Stichopus japonicus) and its related products by high-performance liquid chromatography**. *J Agric Food Chem* 2008, **56**(13):4937-4942.
48. Maltsev, II, Stonik VA, Kalinovsky AI, Elyakov GB: **Triterpene glycosides from sea cucumber Stichopus japonicus Selenka**. *Comp Biochem Physiol B* 1984, **78**(2):421-426.
49. Yang J, Wang Y, Zhang R, Jiang T, Lv Z: **Determination of the triterpene glycosides in sea cucumbers by liquid chromatography with evaporative light scattering and mass spectrometry detection**. *J Sep Sci* 2015, **38**(7):1117-1122.
50. Kariya Y, Watabe S, Hashimoto K, Yoshida K: **Occurrence of chondroitin sulfate E in glycosaminoglycan isolated from the body wall of sea cucumber Stichopus japonicus**. *J Biol Chem* 1990, **265**(9):5081-5085.
51. Kariya Y, Sakai T, Kaneko T, Suzuki K, Kyogashima M: **Enhancement of t-PA-mediated plasminogen activation by partially defucosylated glycosaminoglycans from the sea cucumber Stichopus japonicus**. *J Biochem* 2002, **132**(2):335-343.
52. Kariya Y, Mulloy B, Imai K, Tominaga A, Kaneko T, Asari A, Suzuki K, Masuda H, Kyogashima M, Ishii T: **Isolation and partial characterization of fucan sulfates from the body wall of sea**

**cucumber Stichopus japonicus and their ability to inhibit osteoclastogenesis**. *Carbohydr Res* 2004, **339**(7):1339-1346.
53. Jia ZC, Cong PX, Zhang HW, Song Y, Li ZJ, Xu J, Xue CH: **Reversed-Phase Liquid Chromatography-Quadrupole-Time-of-Flight Mass Spectrometry for High-Throughput Molecular Profiling of Sea Cucumber Cerebrosides**. *Lipids* 2015, **50**(7):667-679.
54. Xu J, Duan JJ, Xue CH, Feng TY, Dong P, Sugawara T, Hirata T: **Analysis and Comparison of Glucocerebroside Species from Three Edible Sea Cucumbers Using Liquid Chromatography-Ion Trap-Time-of-Flight Mass Spectrometry**. *J Agr Food Chem* 2011, **59**(22):12246-12253.
55. Cong P, Li Z, Xu J, Yu J, Chang Y, Xue C: **[Determination of monosialogangliosides in sea cucumbers and sea urchins using liquid chromatography-tandem mass spectrometry]**. *Se Pu* 2013, **31**(5):399-403.
56. Wu HT, Li DM, Zhu BW, Sun JJ, Zheng J, Wang FL, Konno K, Jiang X: **Proteolysis of noncollagenous proteins in sea cucumber, Stichopus japonicus, body wall: characterisation and the effects of cysteine protease inhibitors**. *Food Chem* 2013, **141**(2):1287-1294.
57. Xia CG, Zhang D, Ma C, Zhou J, He S, Su XR: **Characterization and comparison of proteomes of albino sea cucumber Apostichopus japonicus (Selenka) by iTRAQ analysis**. *Fish Shellfish Immunol* 2016, **51**:229-239.
58. Husni A, Jeon JS, Um BH, Han NS, Chung D: **Tyrosinase inhibition by water and ethanol extracts of a far eastern sea cucumber, Stichopus japonicus**. *J Sci Food Agric* 2011, **91**(9):1541-1547.
59. Lee HW, Lim NL, Cho K, Yang HY, Yim KJ, Kim MJ, Lee M, Kim DH, Koh HB, Jung WK *et al*: **Characterisation of inorganic elements and volatile organic compounds in the dried sea cucumber Stichopus japonicus**. *Food Chem* 2014, **147**:34-41.
60. Yan SK, Wu YW, Liu RH, Zhang WD: **Comparative study on major bioactive components in natural, artificial and in-vitro cultured Calculus Bovis**. *Chem Pharm Bull (Tokyo)* 2007, **55**(1):128-132.
61. Kong W, Jin C, Xiao X, Zhao Y, Liu W, Li Z, Zhang P: **Determination of multicomponent contents in Calculus bovis by ultra-performance liquid chromatography-evaporative light scattering detection and its application for quality control**. *J Sep Sci* 2010, **33**(10):1518-1527.
62. Qiao X, Ye M, Pan DL, Miao WJ, Xiang C, Han J, Guo DA: **Differentiation of various traditional Chinese medicines derived from animal bile and gallstone: simultaneous determination of bile acids by liquid chromatography coupled with triple quadrupole mass spectrometry**. *J Chromatogr A* 2011, **1218**(1):107-117.
63. Kong WJ, Xing XY, Xiao XH, Wang JB, Zhao YL, Yang MH: **Multi-component analysis of bile acids in natural Calculus bovis and its substitutes by ultrasound-assisted solid-liquid extraction and UPLC-ELSD**. *Analyst* 2012, **137**(24):5845-5853.
64. Liu Y, Tan P, Liu S, Shi H, Feng X, Ma Q: **A new method for identification of natural, artificial and in vitro cultured Calculus bovis using high-performance liquid chromatography-mass spectrometry**. *Pharmacogn Mag* 2015, **11**(42):304-310.
65. Zang QC, Wang JB, Kong WJ, Jin C, Ma ZJ, Chen J, Gong QF, Xiao XH: **Searching for the main anti-bacterial components in artificial Calculus bovis using UPLC and microcalorimetry coupled with multi-linear regression analysis**. *J Sep Sci* 2011, **34**(23):3330-3338.
66. Yerigui, Wu XH, Wang XJ, Ma CM: **Quantification of Bile Acids in Traditional Animal Medicines and Their Preparations Using Ultra High-Performance Liquid Chromatography-Mass Spectrometry in the Multiple Reaction Monitoring Mode**. *Anal Sci* 2016, **32**(5):499-503.
67. Hu Z, He LC, Zhang J, Luo GA: **Determination of three bile acids in artificial Calculus Bovis and its medicinal preparations by micellar electrokinetic capillary electrophoresis**. *J Chromatogr B Analyt Technol Biomed Life Sci* 2006, **837**(1-2):11-17.

68. Kong WJ, Wang JB, Zang QC, Jin C, Wang ZW, Xing XY, Wu YY, Zhao YL, Yang MH, Xiao XH: **A novel "target constituent knock-out" strategy coupled with TLC, UPLC-ELSD and microcalorimetry for preliminary screening of antibacterial constituents in Calculus bovis**. *J Chromatogr B Analyt Technol Biomed Life Sci* 2011, **879**(30):3565-3573.
69. Peng C, Tian J, Lv M, Huang Y, Tian Y, Zhang Z: **Development and validation of a sensitive LC-MS-MS method for the simultaneous determination of multicomponent contents in artificial Calculus Bovis**. *J Chromatogr Sci* 2014, **52**(2):128-136.
70. Kong W, Wang J, Zang Q, Xing X, Zhao Y, Liu W, Jin C, Li Z, Xiao X: **Fingerprint-efficacy study of artificial Calculus bovis in quality control of Chinese materia medica**. *Food Chem* 2011, **127**(3):1342-1347.
71. Shi Y, Xiong J, Sun D, Liu W, Wei F, Ma S, Lin R: **Simultaneous quantification of the major bile acids in artificial Calculus bovis by high-performance liquid chromatography with precolumn derivatization and its application in quality control**. *J Sep Sci* 2015, **38**(16):2753-2762.
72. Kandrac J, Kevresan S, Gu JK, Mikov M, Fawcett JP, Kuhajda K: **Isolation and determination of bile acids**. *Eur J Drug Metab Pharmacokinet* 2006, **31**(3):157-177.
73. Watanabe S, Kamei T, Tanaka K, Kawasuji K, Yoshioka T, Ohno M: **Roles of bile acid conjugates and phospholipids in in vitro activation of pancreatic lipase by bear bile and cattle bile**. *J Ethnopharmacol* 2009, **125**(2):203-206.
74. He J, Zhang Y, Ito Y, Sun W: **Semi-Preparative Isolation and Purification of Three Tauro-Conjugated Cholic Acids from Pulvis Fellis Suis by HSCCC Coupled with ELSD Detection**. *Chromatographia* 2011, **73**(3-4):361-365.
75. He J, Li J, Sun W, Zhang T, Ito Y: **Preparative Isolation and Purification of Three Glycine-Conjugated Cholic Acids from Pulvis Fellis Suis by High-Speed Countercurrent Chromatography Coupled with Elsd Detection**. *J Liq Chromatogr Relat Technol* 2012, **35**(5):737-746.
76. Wang Y, Jiang H, Huang H, Xie Y, Zhao Y, You X, Tang L, Wang Y, Yin W, Qiu P *et al*: **Determination of neuroprotective oxysterols in Calculus bovis, human gallstones, and traditional Chinese medicine preparations by liquid chromatography with mass spectrometry**. *J Sep Sci* 2015, **38**(5):796-803.
77. Lu XQ, Wang ZH, Hong XK, Sun JJ, Zhang SW: **[Determination of phospholipids in bear bile by isocratic high performance liquid chromatography]**. *Se Pu* 1999, **17**(6):559-562.
78. Ahn CB, Shin TS, Seo HK, Je JY: **Phenolic composition and antioxidant effect of aqueous extract of Arisaema cum Bile, the Oriental Herb Medicine, in human fibroblast cells**. *Immunopharmacol Immunotoxicol* 2012, **34**(4):661-666.
79. Lin DL, Chang HC, Huang SH: **Characterization of allegedly musk-containing medicinal products in Taiwan**. *J Forensic Sci* 2004, **49**(6):1187-1193.
80. Jin C, Yan CX, Luo Y, Li BC, He J, Xiao XH: **Fast and direct quantification of underivatized muscone by ultra performance liquid chromatography coupled with evaporative light scattering detection**. *Journal of Separation Science* 2013, **36**(11):1762-1767.
81. He Y, Wang JZ, Liu X, Xu YX, He ZW: **Influences of musk administration on the doping test**. *Steroids* 2013, **78**(11):1047-1052.
82. Wang GY, Wang N, Liao HN: **Effects of Muscone on the Expression of P-gp, MMP-9 on Blood-Brain Barrier Model In Vitro**. *Cell Mol Neurobiol* 2015, **35**(8):1105-1115.
83. Li DY, Chen BL, Zhang L, Gaur U, Ma TY, Jie H, Zhao GJ, Wu N, Xu ZX, Xu HL *et al*: **The musk chemical composition and microbiota of Chinese forest musk deer males**. *Sci Rep-Uk* 2016, **6**.
84. Kim KH, Lee EJ, Kim K, Han SY, Jhon GJ: **Modification of concanavalin A-dependent proliferation by phosphatidylcholines isolated from deer antler, Cervus elaphus**. *Nutrition* 2004, **20**(4):394-401.

85. Jhon GJ, Park SY, Han SY, Lee S, Kim Y, Chang YS: **Studies of the chemical structure of gangliosides in deer antler, Cervus nippon**. *Chem Pharm Bull (Tokyo)* 1999, **47**(1):123-127.
86. Zhao QC, Kiyohara H, Nagai T, Yamada H: **Structure of the complement-activating proteoglycan from the pilose antler of Cervus nippon Temminck**. *Carbohydr Res* 1992, **230**(2):361-372.
87. Ha YW, Jeon BT, Moon SH, Toyoda H, Toida T, Linhardt RJ, Kim YS: **Characterization of heparan sulfate from the unossified antler of Cervus elaphus**. *Carbohydr Res* 2005, **340**(3):411-416.
88. Li F, Duan JA, Qian DW, Guo S, Ding YH, Liu XH, Qian YF, Peng YR, Ren YJ, Chen Y: **Comparative analysis of nucleosides and nucleobases from different sections of Elaphuri Davidiani Cornu and Cervi Cornu by UHPLC-MS/MS**. *J Pharmaceut Biomed* 2013, **83**:10-18.
89. Zong Y, Zhang H, Niu XH, Li H, Sun JM: **[Alkaloids from cervi cornu pantotrichum and its effect on murine splenocytes proliferation]**. *Zhong Yao Cai* 2014, **37**(5):752-755.
90. Zong Y, Wang Y, Li H, Li N, Zhang H, Sun J, Niu X, Gao X: **Simultaneous quantification and splenocyte-proliferating activities of nucleosides and bases in Cervi cornu Pantotrichum**. *Pharmacogn Mag* 2014, **10**(40):391-397.
91. Liu R, Wang M, Duan JA, Guo JM, Tang YP: **Purification and identification of three novel antioxidant peptides from Cornu Bubali (water buffalo horn)**. *Peptides* 2010, **31**(5):786-793.
92. Zhong S, Cui Z, Sakura N, Wang D, Li J, Zhai Y: **A rapid method for isolation and purification of an anticoagulant from Whitmania pigra**. *Biomed Chromatogr* 2007, **21**(5):439-445.
93. Zhang YT: **[Quality comparison of Hirudo before and after processed by French chalk]**. *Zhongguo Zhong Yao Za Zhi* 2008, **33**(7):766-768.
94. Zheng X, Li J, Chen Z, Liu Y, Chen K: **Purification and characterization of an anticoagulant oligopeptide from Whitmania pigra Whitman**. *Pharmacogn Mag* 2015, **11**(43):444-448.
95. Liu X, Wang C, Ding X, Liu X, Li Q, Kong Y: **A novel selective inhibitor to thrombin-induced platelet aggregation purified from the leech Whitmania pigra**. *Biochem Biophys Res Commun* 2016, **473**(1):349-354.
96. Xiao L, Nie J, Li D, Chen K: **Peptides from two sanguinovorous leeches analyzed by ultra-performance liquid chromatography coupled with electrospray ionization quadrupole time-of-flight mass spectrometric detector**. *Pharmacogn Mag* 2015, **11**(41):32-37.
97. Ren Y, Yang Y, Wu W, Zhang M, Wu H, Li X: **Identification and characterization of novel anticoagulant peptide with thrombolytic effect and nutrient oligopeptides with high branched chain amino acid from Whitmania pigra protein**. *Amino Acids* 2016, **48**(11):2657-2670.
98. Yan D, Li G, Xiao XH, Dong XP, Li ZL: **Direct determination of fourteen underivatized amino acids from Whitmania pigra by using liquid chromatography-evaporative light scattering detection**. *J Chromatogr A* 2007, **1138**(1-2):301-304.
99. Liu L, Jin R, Xu G: **[The comparison of contents of uracil, xanthine and hypoxanthine in five species of leech]**. *Zhong Yao Cai* 1999, **22**(1):8-10.
100. Spindel ER, Gibson BW, Reeve JR, Jr., Kelly M: **Cloning of cDNAs encoding amphibian bombesin: evidence for the relationship between bombesin and gastrin-releasing peptide**. *Proc Natl Acad Sci U S A* 1990, **87**(24):9813-9817.
101. Wang L, Chen Y, Yang M, Zhou M, Chen T, Sui DY, Shaw C: **Peptide DV-28 amide: An inhibitor of bradykinin-induced arterial smooth muscle relaxation encoded by Bombina orientalis skin kininogen-2**. *Peptides* 2010, **31**(5):979-982.
102. Kong Y, Huang SL, Shao Y, Li S, Wei JF: **Purification and characterization of a novel antithrombotic peptide from Scolopendra subspinipes mutilans**. *J Ethnopharmacol* 2013, **145**(1):182-186.
103. Cho G, Han K, Yoon J: **Stability Test and Quantitative and Qualitative Analyses of the Amino Acids in Pharmacopuncture Extracted from Scolopendra subspinipes mutilans.** *J Pharmacopuncture* 2015, **18**(1):44-55.

104. Liu Z, Yuan K, Zhang R, Ren X, Liu X, Zhao S, Wang D: **Cloning and purification of the first termicin-like peptide from the cockroach Eupolyphaga sinensis**. *J Venom Anim Toxins Incl Trop Dis* 2016, **22**:5.
105. Ahn MY, Hahn BS, Lee PJ, Wu SJ, Kim YS: **Purification and characterization of anticoagulant protein from the tabanus, Tabanus bivittatus**. *Arch Pharm Res* 2006, **29**(5):418-423.
106. Ding CH, Cao FP, Wang YH, Yang ML: **[Extraction of fatty constituents from Tabanus bivittatus and their analysis by GC-MS]**. *Zhong Yao Cai* 2013, **36**(2):188-190.
107. Xu JG, Zhang JH, Chen JW: **[Study on the change of the content of cantharidin in Mylabris befere and after biortransfermation]**. *Zhong Yao Cai* 2011, **34**(8):1180-1182.
108. Cao Z, Wang W, Xiao X, Chen K, Liang X, Yu D: **High-level expression and purification of an analgesic peptide from Buthus martensii Karch**. *Protein Pept Lett* 2007, **14**(3):247-251.
109. Zhang R, Yang Z, Liu YF, Cui Y, Zhang JH: **Purification, characterization and cDNA cloning of an analgesic peptide from the Chinese scorpion Buthus martensii Karsch (BmK AGP-SYPU2)**. *Mol Biol (Mosk)* 2011, **45**(6):956-962.
110. Shao JH, Cui Y, Zhao MY, Wu CF, Liu YF, Zhang JH: **Purification, characterization, and bioactivity of a new analgesic-antitumor peptide from Chinese scorpion Buthus martensii Karsch**. *Peptides* 2014, **53**:89-96.
111. Zang M, Liu X, Chen L, Xiao Q, Yuan L, Yang J: **Determination of BmKCT-13, a chlorotoxin-like peptide, in rat plasma by LC-MS/MS: application to a preclinical pharmacokinetic study**. *J Chromatogr B Analyt Technol Biomed Life Sci* 2014, **947-948**:125-131.
112. Gao J, Yin W, Gao T, Deng R, Li X: **Two bioactive compounds from the Chinese scorpion Buthusmartensii Karsch**. *Nat Prod Res* 2014, **28**(10):698-703.
113. Lee JH, Shin JS, Chi EH, Lee IH: **Comparison of the Amino-Acid Content in Pharmacopuncture Extracts Taken from a Scorpion's Body and from Its Tail**. *J Pharmacopuncture* 2013, **16**(2):33-40.
114. Kwon TH, Lee SY, Lee JH, Choi JS, Kawabata S, Iwanaga S, Lee BL: **Purification and characterization of prophenoloxidase from the hemolymph of coleopteran insect, Holotrichia diomphalia larvae**. *Mol Cells* 1997, **7**(1):90-97.
115. Pei K, Cao W, Guo QQ, Xie YH, He ZM, Wang SW: **[Analysis of liposoluble constituents in Holotrichia diomphalia by GC-MS and investigation their anti-inflammatory and analgesic activities]**. *Zhong Yao Cai* 2012, **35**(3):357-360.
116. Li W, Li S, Zhong J, Zhu Z, Liu J, Wang W: **A novel antimicrobial peptide from skin secretions of the earthworm, Pheretima guillelmi (Michaelsen)**. *Peptides* 2011, **32**(6):1146-1150.
117. Yang D, Wang F, Peng J, Xiao L, Su W: **[Study on lipids and other volatile constituents in Pheretima aspergillum]**. *Zhong Yao Cai* 2000, **23**(1):31-33.
118. Li J, Long XY, He L, Liu F, Shu JQ: **[Determination of capsaicin in Pheretima aspergillum from different habitats by RP-HPLC]**. *Zhong Yao Cai* 2006, **29**(5):448-449.
119. Wang YS, Jiang DC, Meng Q, Wang ES: **[Determination of cholesteryl palmitate in Oviductus Ranae by HPLC]**. *Zhongguo Zhong Yao Za Zhi* 2005, **30**(13):990-991.
120. Wang Y, Wang L, Hu Y, Zhang L, Wang Z: **Isolation and identification of two steroid compounds from Oviductus Ranae**. *Nat Prod Res* 2010, **24**(16):1518-1522.
121. Ng TB, Lam YW: **Solenin, a novel protein with translation-inhibiting activity from the traditional Chinese medicinal fish, the sea dragon Solenognathus hardwickii**. *Int J Biochem Cell Biol* 2002, **34**(6):625-631.
122. Zheng L, Chen J, Zhao H, Shi Q, Yang B, Cheng H, Zang J, Wang X: **Rapid finding and quantification of the major antioxidant in water extracts of three marine drug organisms from China by online HPLC-DAD/MS-DPPH**. *Nat Prod Res* 2012, **26**(9):873-877.
123. Su Y, Xu Y: **Study on the extraction and purification of glycoprotein from the yellow seahorse, Hippocampus kuda Bleeker**. *Food Sci Nutr* 2015, **3**(4):302-312.

124. Chen L, Shen X, Chen G, Cao X, Yang J: **A Comparative Study of the Effects upon LPS Induced Macrophage RAW264.7 Inflammation in vitro of the Lipids of Hippocampus trimaculatus Leach**. *J Oleo Sci* 2015, **64**(12):1273-1281.
125. Zhao X, Cui X, Di L, Li W: **[Determination of hypoxanthine and xanthine in hippocampus by HPLC method]**. *Zhong Yao Cai* 2002, **25**(10):716-717.
126. Yin ZQ, Ye WC, Zhao SX: **[Studies on the chemical constituents of Bombyx batryticatus]**. *Zhongguo Zhong Yao Za Zhi* 2004, **29**(1):52-54.
127. Cui XQ, Li XC, Wang L, Chen RY: **[Chemical constituents from Faeces bombycis]**. *Zhongguo Zhong Yao Za Zhi* 2008, **33**(21):2493-2496.
128. Park JH, Lee DG, Yeon SW, Kwon HS, Ko JH, Shin DJ, Park HS, Kim YS, Bang MH, Baek NI: **Isolation of megastigmane sesquiterpenes from the silkworm (Bombyx mori L.) droppings and their promotion activity on HO-1 and SIRT1**. *Arch Pharm Res* 2011, **34**(4):533-542.
129. Zhou GX, Ruan JW, Huang MY, Ye WC, He YW: **[Alkaloid constituents from silkworm dropping of Bombyx mori]**. *Zhong Yao Cai* 2007, **30**(11):1384-1385.
130. He JB, Yan YM, Ma XJ, Lu Q, Li XS, Su J, Li Y, Liu GM, Cheng YX: **Sesquiterpenoids and diarylheptanoids from Nidus vespae and their inhibitory effects on nitric oxide production**. *Chem Biodivers* 2011, **8**(12):2270-2276.
131. Hahn BS, Cho SY, Wu SJ, Chang IM, Baek K, Kim YC, Kim YS: **Purification and characterization of a serine protease with fibrinolytic activity from Tenodera sinensis (praying mantis)**. *Biochim Biophys Acta* 1999, **1430**(2):376-386.
132. Hahn BS, Cho SY, Ahn MY, Kim YS: **Purification and characterization of a plasmin-like protease from Tenodera sinensis (Chinese mantis)**. *Insect Biochem Mol Biol* 2001, **31**(6-7):573-581.
133. Weiss IM, Kaufmann S, Mann K, Fritz M: **Purification and characterization of perlucin and perlustrin, two new proteins from the shell of the mollusc Haliotis laevigata**. *Biochem Biophys Res Commun* 2000, **267**(1):17-21.
134. Cai Z, Wu J, Chen L, Guo W, Li J, Wang J, Zhang Q: **Purification and characterisation of aquamarine blue pigment from the shells of abalone (Haliotis discus hannai Ino)**. *Food Chem* 2011, **128**(1):129-133.
135. Li TF, Ye B, Song LY, Yu RM: **Isolation and purification of two antioxidant peptides from alcalase hydrolysate of Arca subcrenata**. *Zhong Yao Cai* 2014, **37**(7):1140-1144.
136. Ma Y, Berland S, Andrieu JP, Feng Q, Bedouet L: **What is the difference in organic matrix of aragonite vs. vaterite polymorph in natural shell and pearl? Study of the pearl-forming freshwater bivalve mollusc Hyriopsis cumingii**. *Mater Sci Eng C Mater Biol Appl* 2013, **33**(3):1521-1529.
137. Zhang JX, Li SR, Yao S, Bi QR, Hou JJ, Cai LY, Han SM, Wu WY, Guo DA: **Anticonvulsant and sedative-hypnotic activity screening of pearl and nacre (mother of pearl)**. *J Ethnopharmacol* 2016, **181**:229-235.
138. Oguri K, Kawase M, Harada K, Shimada-Takaura K, Takahashi T, Takahashi K: **Longgu (Fossilia Ossis Mastodi) alters the profiles of organic and inorganic components in Keishikaryukotsuboreito**. *J Nat Med* 2016, **70**(3):483-491.